# JOURNAL

OF THE

# FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE PROMOTION OF THE MECHANIC ARTS.

VOL. CLVII, No. 5. 79TH YEAR. MAY, 1904



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## Savage and Civilized Dress.


BY EDWIN SWIFT BALCH,*
Member of the Institute.


The various material things placed by man on his body have a two-fold function: protection, ornament. Either they are intended to ward off the extraneous influences of heat and cold and humidity; to protect the feet from stones and wet, and the head and body from sun or blows or thorns; or else, as with jewelry, painting or tattooing, they are used with the idea of ornament, to make the person more beautiful. The idea of adornment, however, exists also to a certain degree in the garments put on for protection, and their shape and materials are often due to the dictates of that mysterious something known as fashion.

It might be assumed that the superior development of the brain of civilized man would result in some form of dress far better and more tasteful than anything found among savages, yet it may be doubted whether this is the


* Copyright 1904 by Edwin Swift Balch.

case to anything like the degree which might be expected. Even to-day in some places civilized man may obtain valuable hints from savage or semi-civilized peoples.

The garb of civilization was elaborated by races living in temperate zones, neither very hot nor very cold, and, therefore, it is primarily adapted to middle, not to extreme, temperatures. It was developed by the conditions of the environments in which the white races lived, and these conditions produced its advantages and its limitations, for it has been taken and not entirely successfully to both warmer and colder climes.

Of course, there can be no hard-and-fast laws about clothing. What is good in one place is bad in another; what is suitable for one person may be unsuited to his neighbor. Improved systems of reformed clothing may fail outside of their climatic limits. For instance, the all-wool system, for which so much has been claimed, is well enough for some persons in temperate latitudes in winter, but it is a burden to the flesh if the thermometer rises beyond a certain point, and, judging by the reports of many polar explorers, notably Dr. Kane * and Commander Peary,† it is inadequate for some persons at the other extreme.

The methods of covering the body used by savages are as a rule wonderfully adapted to meeting the demands of the climate and temperatures of the wearer's habitat. On account of the more or less precarious hand-to-mouth state in which savages live, and the difficulty with which they procure supplies with primitive weapons, they are forced to use the simplest means to make their clothing answer their needs, and, as might be expected, the savages exposed to cold climates have developed their garments mainly for protection, and those living in hot climates mainly for adornment.

For simplicity and protection combined, one of the most effective garments ever devised is the fur gown of the Mongol and Tatar races of Central Asia. Living on horseback

* "Arctic Explorations," Philadelphia, 1856.
† "Northward Over the Great Ice," New York, 1898.

on the high bleak steppes of the Gobi plateau, they had to devise something which would keep out the cold and yet be extremely simple. Their gown is really a long fur general-utility ulster. Pulled up and belted in at the waist, it does on horseback or on foot as a wrap, and the sleeves are long enough to cover the hands and act as gloves. At night the belt is loosened and the gown, which reaches to the feet, is sufficiently lengthy and warm to sleep in.

The bear, reindeer, seal and sea birds serve the peoples of the Arctic for their fashions as well as their menu. Yet so admirably have the northern tribes adapted their means to their ends, that Arctic explorers have learned many lessons from them. The Eskimo dress is so suitable to surrounding conditions that with but few changes it was practically adopted by the Peary expeditions. The Eskimo woman evolved bifurcated garments; very naturally, for how could anyone hampered with skirts wade through the snows of Smith Sound? Mr. F. G. Jackson* started on his journey to Siberia with a fur outfit made in London, but he soon discovered that the Samoyede furs were so much more intelligently cut for sledge traveling, that he threw away his London furs and used the native dress. As the result of his experience, Mr. Jackson† fitted out his party for Franz Josef Land with furs cut in London on the Samoyede pattern. These models have evidently come to stay, for one of the London equipment stores now advertises soviks, malitzas, loupthu and pimmies. Here, therefore, is a case where, within the last few years, the cut of the dress of savages has been found superior to and has replaced for certain purposes the garments thought out in civilization.

Another garment which civilized man has received from a semi-savage race is the putty. This was invented by the mountaineers of the Himálaya, and it is slowly spreading to all parts of the world. It is now a part of the British army uniform, and it was used by the English troops through the great Boer war. It is largely used by mountain climbers

* "The Great Frozen Land," London, 1895.

† "A Thousand Days in the Arctic," New York, 1899.

also, and it is stated that the weaving of putties has begun on a small scale in Switzerland.

The costumes of semi-civilized peoples are not always the best, however. The Highland kilt seems principally adapted to kill off the weaker specimens of the canny Scot. The Tyrolese costume, with its low shoes, footless stockings and black chamois knee-breeches, good enough though it is in the valleys, above the snow line is so impractical and so unprotecting that it is gradually giving way to the trouser, the knickerbocker and the laced boot. Yet four or five centuries ago at least the Tyrolese, when still practically uncivilized, invented the rücksack or back-bag, and this, by its superiority to every form of knapsack or haversack, is gradually superseding these among explorers and mountaineers.

When we turn to the inhabitants of the tropics, we find their dress or undress, as a rule, equally adapted to their necessities. Protection is much less thought of than adornment. Many of the races along the Equator go about without a scrap of clothing, and all they do to their persons is done with the idea of adornment. The Mashikulumbwe, for instance, according to Dr. Holub,* do no dressing beyond fixing up their wooly pates into a sort of upright queue 50 or 60 centimeters long. In fact, many of the savages of the tropics seem to have absolutely no idea of what clothes are made for. If an Australian black is presented with an overcoat, the chance is he will parade around in it all day in the sunshine and at night take it off and catch pneumonia in consequence. Humboldt† found a tribe of Indians on the Orinoco, to whom coats so thoroughly suggested ornament, that they actually painted blue jackets with black buttons on their bodies as a decoration.

The noteworthy point about the attitude of tropical races towards dress is that their lack of covering is probably the best arrangement for withstanding the circumstances of climate in which these non-dressing races live.

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* "Seven Years in South Africa," London, 1881.

† "Personal Narrative," etc., Vol. IV.

Whether our clothing, an exotic from temperate climes, is healthier in the tropics for white men is a question, but there is some evidencce that it is not so healthy for the natives. For instance, a British official reported that the introduction of trousers and shirts among the negroes of the Niger was a mistake, because formerly these men would jump into every stream for a bath, with the result that they were always clean, while now, on account of their clothes, they are hampered in this practice, and, having no idea of washing as we do, the result is they are dirty and malodorous. The Comte de Beauvoir* reports a case of a Dutch official in Java bringing up his son in native style, facing the sun with almost no clothes and without a hat, and when de Beauvoir saw the boy he was thriving and had escaped the diseases to which most European children in the tropics succumb. The Arab goes shoeless and wears a turban. Some Europeans of much experience in rough traveling, notably Sir Martin Conway,† consider the turban the best headgear in both hot and cold climates. Of course the turban was really evolved to keep out the rays of the sun, but the Arabs, who, perhaps, do not clearly understand the reason, have, according to Mr. Chanler,‡ a proverb directly the antithesis of ours, and that is, that if a man wishes to be healthy, he must keep his head warm and his feet cool. The South American Indians in the Brazilian forest wear no clothes, but daub their bodies all over with ochres and other earths as a safeguard against mosquito bites. A clever Frenchman, the Comte de Gabriac,§ who crossed South America, came to the conclusion that the costume of the Indians was made so necessary by circumstances that the most elegant Parisian traveling in the Brazilian forest would adopt it little by little; the heat first of all would force him to take off one article of dress after another, and when he had a dozen streams to cross in a day's

* "Voyage Autour du Monde," Paris, 1872, Vol. II.
† "The Alps from End to End," Westminster, 1895.
‡ "Through Jungle and Desert," New York and London, 1896.
§ "Promenade à Travers l'Amérique du Sud," Paris, 1868.

journey he would be obliged to undress entirely; finally, if he remained long in the country, de Gabriac thought "it would be an intelligent precaution on his part to cover his skin with substances suited to protect it from the execrable mosquitoes."

Nevertheless, some savage tribes of the tropics are but ill protected against their surrounding climatic conditions. The Touaregs, according to Mr. Harding King,* dress in thin black cotton garments. The color, of course, is the best absorbent of the sun's heat, and the material neither keeps out its rays nor the chill of the, sometimes, freezing nights of the Sahara. The force of fashion is well shown by a curious custom of this same people. The Touareg always keeps his face covered with a litham, a sort of mask; he lives in it, he sleeps in it, and when eating or drinking merely pulls it away from the lower part of his face and passes the food or cup up to his mouth from beneath it. The litham was undoubtedly originally intended as a protection against the sun and the scorching winds, and according to Sir Frederick Lugard,† especially against the impalpable dust of the Sahara, but the original use of this garment has been so forgotten through the abuse of custom that the Touareg now considers it immodest to show his face even to members of his own family.

Civilized peoples make mistakes in other ways. A point of hygienic importance in connection with clothing is the need of ventilation. The human animal breathes with his entire skin; refuse matter is thrown off as perspiration through every pore. Arrest this process entirely for a few hours and you kill the man; arrest it partially and you produce more or less sickness. The fact is well known, but in the garments of civilization it is almost universally unrecognized. It is only necessary to rip the lining of any coat to find the shoulders, chest and back padded with great wads of cotton, wool, horsehair and canvas, which hinder the escape of perspiration and prevent transpiration. Sim-

* "A Search for the Masked Tawareks," London, 1903.

† *The Geographical Journal*, London, Vol. XXIII, 1904, page 12.

ilar unhygienic results are obtained by lining waistcoats with canvas, by corsets, by the abuse of starch, and in other ways. My own experience in the matter may be, perhaps, worth mentioning. I used to suffer severely from rheumatism in the shoulder joints, but since wearing woolen suspenders, and having every bit of padding and interlining removed from my coats and waistcoats, I have been entirely free from the agonizing pains it caused. It may be added that I have never convinced any doctor that the matter was of medical importance. Savages, of course, know nothing about hygiene from any process of reasoning; but, owing to want of means and materials, they are unable to pad ventilation out of their clothes as we do, and fur-wearing tribes all divest themselves of their furs as much as possible in their tents and huts to let the perspiration dry off.

The principles underlying proper ventilation in garments are simple. The materials should be porous, and the more impervious materials should be inside. The ordinary modern bedding, first a sheet and then a blanket, is correct. Woolen clothes can be worn comfortably over woolen, cotton, silk or linen undergarments. Any one who will take the trouble to make a few experiments on himself will quickly discover that one cannot reverse the process without at least some disadvantage. A favorite plan now is to wear an all-woolen shirt under a cotton one. The woolen shirt has a tendency to overheat the wearer and put him in a perspiration, which is prevented from escaping by the cotton shirt, and the victim feels oppressed and uncomfortable without realizing that it is due to his own hygienic blunder. A number of polar explorers, de Gerlache,* Abruzzi,† and others, found woolen clothes more comfortable than furs, and Walter Wellman‡ stated the reason clearly in the following words: "Wool is far and away the best fabric for arctic wear. Even wool will gather moisture, but it is infinitely better than fur. Wool permits the

* "Quinze Mois dans l'Antarctique," Bruxelles, 1902.
† "On the 'Polar Star' in the Arctic Sea," New York and London, 1903.
‡ *McClure's Magazine*, Vol. XIV, April, 1900.

moisture of the body to pass through the fabric and congeal outside, where it can be brushed and shaken off, while furs retain it within. Two, three or more thicknesses of wool are better than one of equal weight."

Under the head of adornment must be classed various mutilations and injuries done to the human body. Some tribes of Indians compress the heads of babies to alter their shape; some African negroes introduce rings in the women's lips; some savages slash themselves and treat the wounds in such a way as to leave great welts; some tribes pull out or file into points their front teeth. These mutilations of the person are done either from some strange notion that they improve the appearance, or, as Dr. Donaldson Smith* found among the tribes of Lake Rudolph, to make the women so ugly that other more powerful tribes should not care to run away with them. In no case, however, do real savages mutilate themselves in such a way as to impair the full use of any portion of their bodies. The reason of this is, of course, because a maimed individual would have no chance in the struggle for existence under the conditions of hunting and nomad peoples.

With semi-civilized or civilized races, however, it is another story. The Hindoo fakirs find all sorts of ridiculous positions into which to twist and distort their bodies so as to render them useless. The Chinese crush the feet of girl babies into stumps, and consider this mutilation as a mark of birth and high rank. This curious custom probably had its origin in the desire to make women stay at home. It would never have been invented by hunters or nomads, as women who could not walk could not exist under the conditions of completely savage life.

Civilized peoples have achieved two deformities of the human body, both of which are practically unknown among savages. The first of these is the crushing in of the ribs and the displacement of the lungs and the abdomen, often caused in the female sex by the misuse of the corset and by tight lacing. The evils of this practice are universally

* "Through Unknown African Countries," London and New York, 1897.

known among medical men. Apparently such a custom is found among savages only in New Guinea, where Mr. Octavius C. Stone * saw *men*, not women, constricting their waists so tightly with a stiff bark belt, that in one case where the waist measured about 53 centimeters the flesh above and below it bulged out to about 70 centimeters.

The most curious deformity, however, achieved by civilized people is that produced in their feet by means of the civilized shoe. In the Middle Ages there was an iron instrument of legal torture called the boot, which, when put on and gradually made smaller, crushed the bones and flesh into a pulp. It seems to have been effective in its object of wringing any confession desired from the victim. In modern times the process is more gradual. It begins when the victims are tiny babies. Born in almost every case with feet as perfect as those of the Dying Gladiator or the Venus de Medici, babies have their feet gradually made into deformities by the shoes which the loving parents place upon them. Although the process is slower and less torturing than was the use of the boot in the Middle Ages, yet it is so rather in degree than in kind.

The strangest thing is that few persons seem aware of the irrationality of this. They are so used to deformed feet that a real deformity, where all the toes are jammed into a point, is considered a pretty foot, while a really natural foot is looked on as a deformity. Colonel Henry,† chief medical officer at Camp Black, in 1898, stated in an interview that a large proportion of the volunteers for the United States Army had to be rejected on account of imperfect feet, and if any one will look at the shoes worn until recently by the people in any large city of Europe or America, this statement will not seem surprising; everywhere are seen pointed toes and high heels. In the foot of a man who has never worn shoes, the four small toes go out straight and the great toe curves away from them a little, and leaves a space sometimes a centimeter wide between it and the other toes. In the civilized foot the great toe curves in towards the small

* "A Few Months in New Guinea," Harper & Brothers, New York, 1879.
† *The Sunday Times*, New York, June 5, 1898.

toes, generally touching them, and constantly this distortion is carried so far that the great toe is dislocated at the joint, forming a bunion. And a bunion is just as much a deformity as a humped back. Bunions are the main evil produced by the civilized shoe; but, of course, there are many minor ones, such as corns and ingrowing toe nails.

These pedal deformities may perhaps be assigned to two mental causes: ignorance and vanity. Scarcely any one realizes what an anatomically perfect foot looks like. Even modern sculptors not unusually give their statues deformed feet, a blunder not made by Greek or Japanese sculptors. People seem to have an inrooted belief that their feet look better in certain kinds of boots. They are not concerned as to whether the shoes conform to the shape of the foot and therefore as to whether they fit. A gentleman in painfully tight shoes told me "they looked neater," and a lady with a pair of fearfully deformed joints said, "I must sacrifice something to beauty." It need not be supposed that there is anything new about pointed toes and high heels, which apparently have an inborn attraction for Eurasian races. In Moscow are preserved a pair of boots belonging to one of the Tsars of about the year 1500 A.D. These are of emerald-green leather with small high heels and razor points in the middle of the toes; in fact, they would be ultra fashionable to-day.

High heels also are responsible for much ill carriage of the body, for they set the feet at an angle to the ground and therefore the knees must be slightly bent and the spine a little curved forward to give the proper equilibrium. Any one can prove this by experimenting with shoes with high heels and then with slippers without heels, in which it will be found that the back and legs immediately straighten out; in other words, that a more normal position is assumed. It is, however, a hopeful sign that modern shoemakers have begun to find out how to shape boots, for the sharp point is beginning to be placed more in front of the great toe.

Among savages neither high heels nor pointed toes, nor, indeed, any mode of deforming the feet, seem to exist. I have seen a good many semi-savages—Indians on the plains

and in Alaska, Eskimos in Canada, negroes in North Africa and Asiatics in the Russian Empire, and they have always had handsome, undeformed feet. I have searched in every way I could think of into the footgear of savages, among specimens in museums, in books, in drawings, in photographs, from all of which it appears that savages do not distort their feet. They wear sandals or moccasins or fur boots, but their footgear always conforms to, and does not have to be broken in by, the foot. The only specimens of the white races whose feet seem to remain undeformed are to be found among the poor dwellers in out-of-the-way districts, who habitually go barefoot. I remember a small fisher boy running over the tumuli at Locmariaquer, whose great toes curved away from the other toes, and, as he jumped from rock to rock, he caught on with a grip which resembled the prehensile qualities of the hands of monkeys. In out-of-the-way districts of Hungary and Croatia one may see hundreds of women barefoot. The older ones, those fifty or sixty years old, generally have beautiful feet; the younger ones, those twenty or thirty years old, mostly have enlarged joints. The explanation is simply that the older ones wear the native moccasin or slipper, which conforms to the foot, while the younger ones have adopted the civilized boot, which has been introduced within the present generation.

In regard to things purely ornamental, savages have certainly some queer customs, but so also have civilized peoples. Savages wear eagle or parrot feathers, but we wear ostrich feathers; savages place rings in their noses, but we place rings in our ears. Savages, however, have never invented the hair-destroying stove-pipe hat, nor the shapeless bags we call trousers, nor black dress suits, nor high collars, nor bustles, nor crinolines. A Hindoo gentleman recently accurately criticized our women's hats, when he spoke of them as curious straw baskets ornamented with dried grasses and dead birds. The latter practice is more barbarous than any fashion of savages, for we know, which savages do not, the indispensable value of birds to humanity in keeping down insects. In fact, our practice of destroying birds to use as ornaments is about as rational as would be an organized shooting down of policemen by law-abiding citizens.

If we look at savage and civilized dress from both the utilitarian and the artistic points of view, it does not seem as though civilized man had improved nearly so much on savage man as might have been expected, proving that here, at least, reason has but small influence as compared with instinct, custom and fashion.

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## COAL MINED BY MACHINES.

Characteristic of the age is the growing use of mine machines in the bituminous coal mines of the United States. The report of Mr. Edward W. Parker on the Production of Coal in 1902, which forms part of the annual volume of Mineral Resources, published by the United States Geological Survey, shows that 5,418 machines were employed in 1902 as against 2,622 in 1898.

In a few of the States there was a decided decrease in the number of machines used, but with the exception of Wyoming these were States in which comparatively little development in the mechanical production of coal has been made. All of the States where the use of machines had exerted any significant effect upon the production prior to 1902 showed substantial increase in that year.

Ohio claims the largest proportionate production by the use of machines, more than half the product of that State in 1902 having been machine-mined. Ohio also stands second in the total of machine-mined coal, Pennsylvania being first. Illinois ranks third in the amount of coal produced by machines, West Virginia fourth, Kentucky fifth, and Indiana sixth. It will be noted that these six States comprise the well-known "competitive" coal fields. In 1902 they produced 75 per cent. of the total output of bituminous coal in the United States and 94 per cent. of the total tonnage of machine-mined coal.

The total machine-mined product reported for 1902 was 69,611,582 short tons, an increase, as compared with 57,843,335 short tons in 1901, of 11,768,247 short tons, or 20 per cent. As the total production of bituminous coal in the United States in 1902 was 15 per cent. larger than in 1901, it will be seen that on the whole the production by the use of machines has more than kept pace with the increased output. In fact the percentage of the machine-mined product to the total output has increased from 26·68 in 1901 to 26·09 in 1902.

The statistics for 1902, as contained in the Survey's report, have all been obtained from the reports made to the Geological Survey by the coal-mine operators. It is possible that the falling off in machine production in some States has been due to the failure of operators to reply to this particular inquiry on the Survey schedules. Where no machines have been reported, it has been considered that none was in use, although the same mines may have reported the use of machines in 1901.

Of the 5,418 machines in use in 1902, 3,185 were of the "pick" or "puncher" type, 2,182 were chain-breast machines, and 51 were of the long-wall design.

# Mechanical and Engineering Section.

*Stated Meeting, held Thursday, February 25, 1904.*

## The Manufacture of Hydraulically Forged and Rolled Solid Steel Railway Wheels.

By Henrik V. von Z. Loss, M.E.,
Member of the Institute, Member American Society Mechanical Engineers.

Railway transportation, with its problems—road bed as well as rolling stock—has in later years claimed more than its share of capital and inventive thought, and as was naturally to be expected, in no other field of engineering have the undertakings been on as large a scale or of more practical and scientific interest to our profession.

It has been the speaker's fortune to have been associated with the development of the steel car, and, as his experience in this field has been somewhat extensive, the necessary results of the introduction of that car, and its technical requirements as to details, became early very apparent.

Immediately upon the introduction of the 100,000-pound car, the repair sheets of the different railways showed abnormal accounts, thus on the face of it tending greatly to eliminate the possibility of the adoption of this new innovation in transportation. A little investigation, however, proved that an unexpectedly large amount of the expense was caused by breakage of the wheels, and having no direct bearing upon the car structure proper.

That such should be the result was, after all, quite natural, when one considers that though the car capacities were but recently increased from 60,000 pounds up to 80,000 pounds, and finally up to 110,000 pounds, the substructure proper, which is represented by the wheels, was practically left untouched, barring the occasional adding of 50 to 100 pounds in weight, a heavy iron wheel of 33 inches diameter weighing to-day about 750 pounds.

It is also pertinent to recall, in this connection, that both the axle and the rail have been increased in large ratios to

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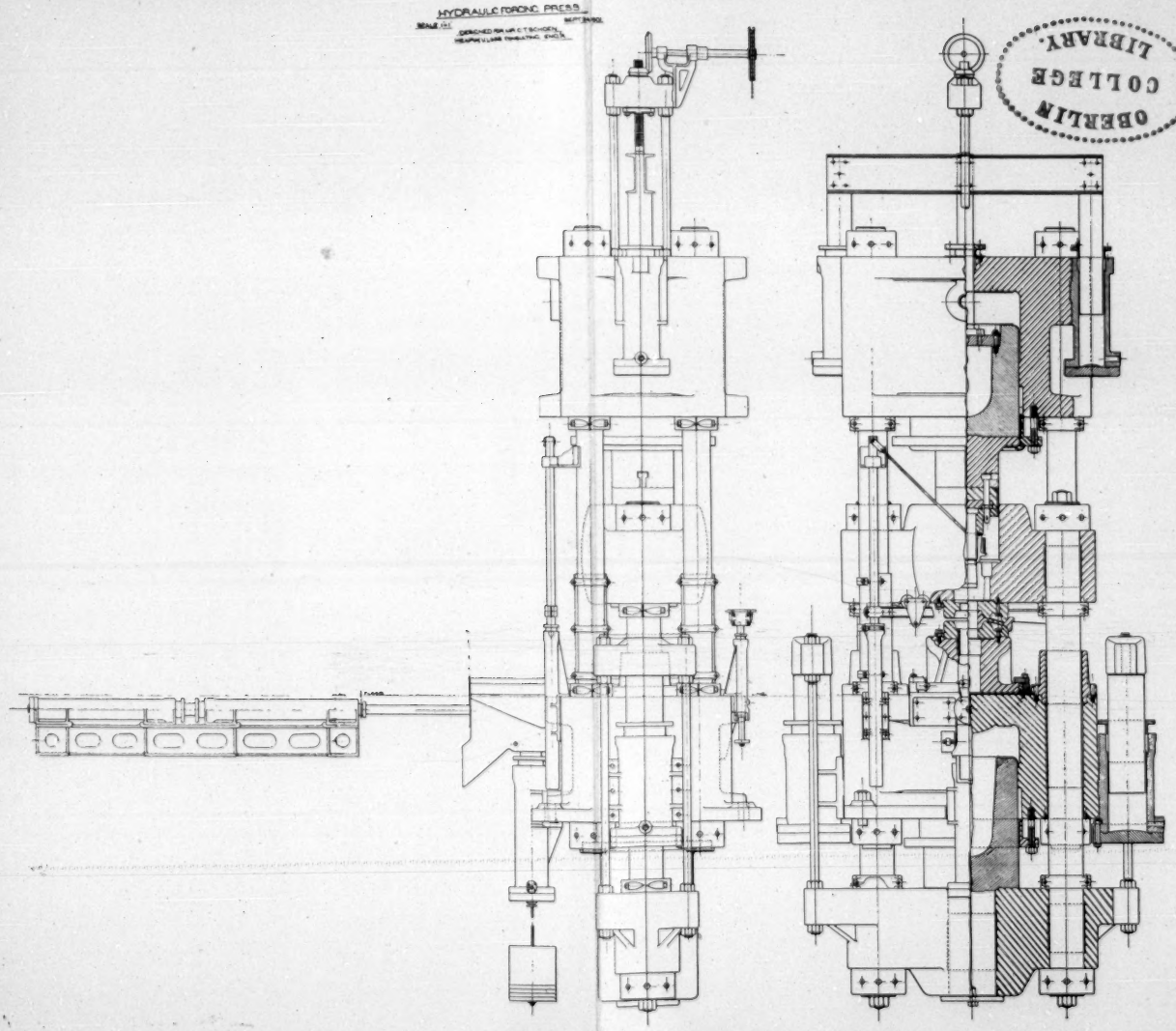



PLATE I.—5,000-ton Hydraulic Forging Press.

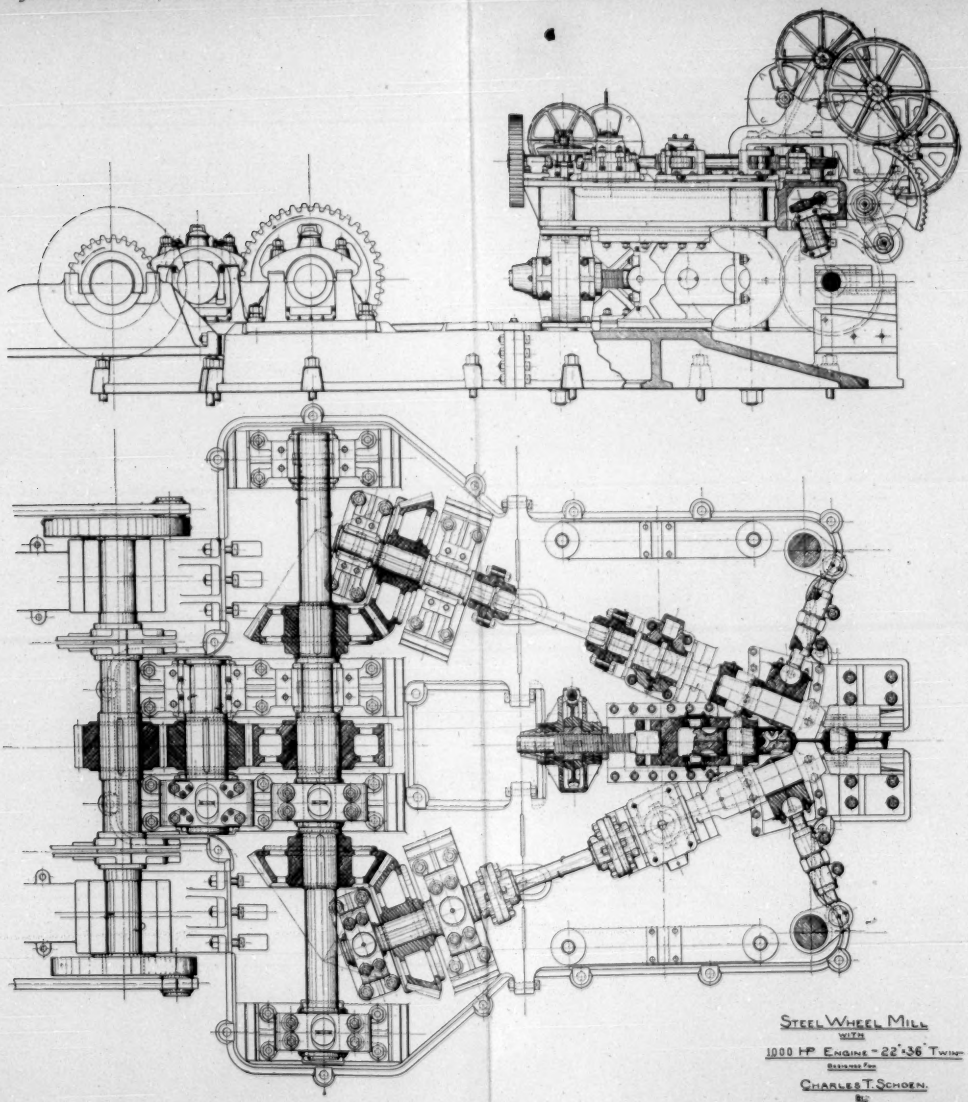
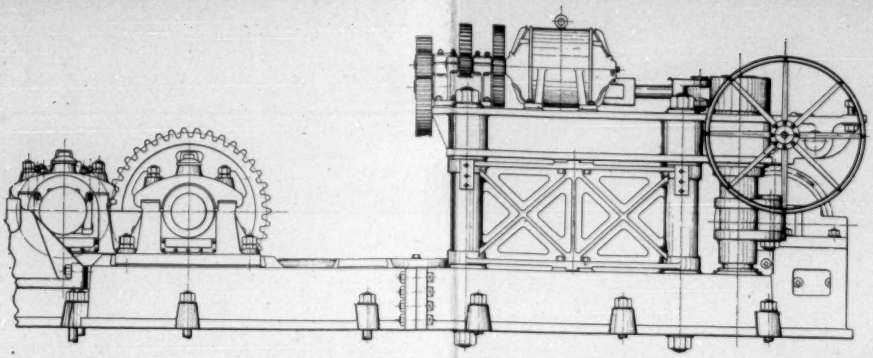

STEEL WHEEL MILL
WITH
1000 HP ENGINE - 22"-36" TWIN-
DESIGNED FOR
CHARLES T. SCHOEN.
BY
HENRIK V. LOSS
CONSULTING ENGINEER.

PLATE II.



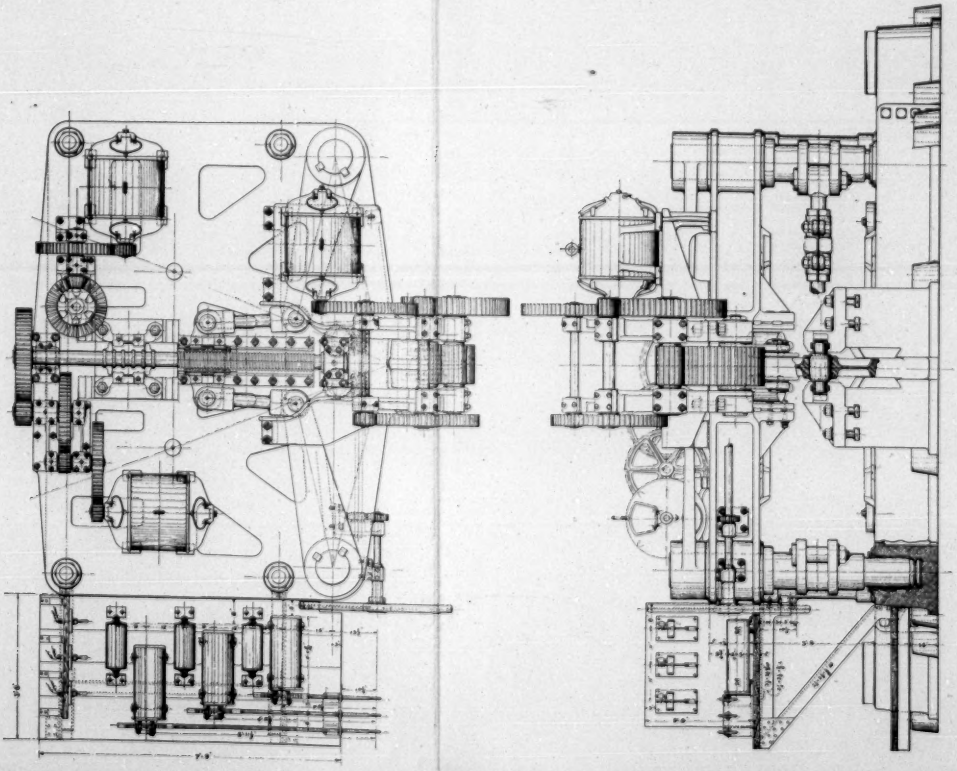


PLATE IIa.

sustain the increased duties. The swaying of the heavy steel car, in connection with its increased static load, proved, in many instances, ruinous to the flanges when passing switches or curves; and Mr. Schoen, the inventor and promoter of the steel car, suggested several years ago the possibility of applying a solid steel wheel, because of the fact that no additional weight or thickness could be given to the wheels at the spot where they most needed it, namely: at the root of the flange. In fact, the full economy of the large capacity steel car has never been realized, nor will it be until supported by a wheel, the flange of which will permit increased mileage with a practical elimination of wrecks. With this in view, all data and processes bearing upon the subject were investigated, and, about two years ago, the writer undertook to design for Mr. Schoen a plant to accomplish the purpose with a final result, the success of which is witnessed by the samples herewith shown to you, as well as by the wheels now being tried on the different railways; and again, as indicated by the photographs of the machinery and product which are attached to this paper.

The development of a perfect wheel is a matter of evolution. The first step in this series, after making the plain cast-iron wheel, was to make it with chilled tread. The next, in order to secure safety, was to make a steel tire and fit it to a wheel center. This style of wheel is now used almost exclusively throughout Europe, and to a considerable extent in the passenger service of this country; but, as there is a great deal of work expended in producing such a wheel, it naturally becomes very expensive. It appears that the ideal product should be made of steel of proper quality, all in one piece and forged and rolled to a perfect finish.

In order to make a successful steel wheel the balance sheet must again, first of all, be taken care of, and with this in view the price of such a wheel must be limited to a figure which shall bear a certain relation to the one of cast iron. In order to throw some light on the subject, the writer secured, a few years ago, some information from one of our leading railways, which will enable us to form an approximate opinion. It was found from two years' run, covering

5,320 cast-iron wheels (33 inches diameter and all legitimately worn out), in passenger service, that the average life per wheel was 56,000 miles. One hundred steel-tired wheels of the same diameter, and used in the same class of service, and similarly worn out, had an average mileage each of 265,000, or a ratio of 4·71 to 1 in favor of the steel wheel. Two hundred and sixty-five thousand miles is a very conservative estimate for steel wheels, because individual records of wheels show mileage as high as 380,000; showing what, under proper conditions, can be looked upon as a possibility.

Referring to the application of steel wheels for freight service, the railroad in question kept no records of the mileage for any wheel used in this branch of service; but with cast-iron wheels, the date of the wheel as cast upon it will give the desired information. During the same years 62,461 wheels, all legitimately worn out, were withdrawn from the service, representing an average age per wheel of eight years and three months. The average mileage per year of a freight car, as taken on the same railroad and during the same years, appeared to be 9,243. Multiply the average life of a wheel by the average yearly mileage of the car, and the result will give a fair approximate value of the average mileage per wheel for its entire life.

Pursuing this process, the average mileage of a cast-iron chilled wheel in freight service was found to be 76,260. There were no steel wheels used for freight purposes; but if we assume that the proportion between the life of a steel-tired wheel and a cast-iron chilled wheel remains the same, whether in passenger or freight service, the average life of a steel-tired wheel, under a freight car, would be 360,000 miles, or representing a life of over thirty-five years.

The above mileages are based upon the practice of the average wooden 60,000-pound car, and must be greatly modified when applied to the modern 55-ton structure. It has been stated by the representatives of one of the greatest freight-carrying railroads of the country, that the average mileage of a cast-iron wheel, when carrying the large capacity steel car, is about 35,000; and if we use this figure

as a basis, the life of a steel wheel should be in the neighborhood of 150,000 miles when based upon the data previously given. Using these two figures as a foundation for a financial comparison, the following data explains itself:

| | |
|---|---|
| Assume as average service of cast-iron wheels (miles) | 35,000 |
| " " " " " steel " " | 150,000 |
| " " cost per wheel of cast-iron " | $8 75 |
| On this basis the cost of each 150,000 miles of service, with cast-iron wheels, would be | $37 45 |
| Less scrap value of about 4·25 cast wheels at 70 cents per hundredweight | 17 98 |
| Net cost for 150,000 miles with cast-iron wheels | $19 47 |

Adding to this last figure the value of a scrap steel wheel, which is about $5, we find the allowable price for a wheel of this type to be $24.47, not allowing for any other saving due to immunity from wrecks, as caused by defective cast-iron wheels, etc.

In the above it has also been assumed that the boring and mounting of the different cast-iron wheels is about equivalent to the "truing up" of the steel wheel.

Another point, which may be worth mentioning in this connection, is the fact that as the cast-iron wheel weighs at least 700 pounds, while the steel wheel weighs about 80 pounds less, there is a saving in dead weight per car of at least about 640 pounds.

The process as used in the manufacture of our new wheel is about as follows:

A round ingot, approximating in outlines the shape of a wheel, but of a quite smaller diameter and greater web thickness, is placed in a movable bottom die-holder of a 5,000-ton forging press; this machine being illustrated by Plate I, where the blank is first reduced in thickness. During this same stroke the hub is forged and finished and the hole punched—all in one operation. The original blank or ingot is about 4 inches less in diameter than the finished wheel, and its central body has a thickness of from 2 inches to 2¼ inches, which is reduced by rolling to a final web thickness of wheel of from ⅞ inch to an inch.

Plates II and IIa represent the general drawing of the

mill, showing also part of the engine, while Plates III, IV, V, VI and VII are different views taken from the works recently erected in Pittsburg by Mr. Charles T. Schoen for the manufacture of the new wheel, and which represent the interior of the mill building with machinery and product, and also part of the power-house.

The forging press consists of a large bottom cylinder located below the floor, working through vertical, hollow-forged nickel steel 15-inch bolts on a movable cross-head, to which the top die is attached. The bottom die-holder is stationary from a vertical point of view; but is operated horizontally by a hydraulic cylinder, so as to facilitate the introduction of the blank and removal of the finished product. Above the forging cross-head with its top die, is located another large hydraulic cylinder in which works a piston, the lower end of which engages into the cross-head and is guided by the same. This piston performs two functions, viz., first, of punching the hole, after which the piston continues downward, coming to a stop inside the forging cross-head, adding its pressure to that already existing upon the top die, and hence finishing the hub under the combined pressure of the two rams, which amounts to about 5,000 tons. The punches are not stripped; but they are split automatically, leaving the lower half remaining in the wheel blank, and this is afterwards removed before going to the rolling-mill. Most of the mechanism is automatic, and hydraulic cranes are attached so as to minimize labor.

The two conical rolls of the rolling-mill are driven by a 1,000-horse-power engine, the general arrangement of which is all shown on the photographs. Electric alarms call the attention of the operator when the thickness of the web and the rim have reached their limit. The work of the actual rolling process consumes from one and one-half to two minutes.

The third and last step is the coning of the wheel, which is done in a separate 1,000-ton press that is provided with the proper dies and handling mechanism. In this machine the rim is pushed downwards so as to give the proper relation between the edge of the hub and the edge of the flange, and

it should be added here that this peculiar shape of the wheel furnishes a small degree of elasticity, which is beneficial under load.

The entire three processes are performed in one heat, and the transportation machinery, from furnace to press, from press to rolling-mill, and again from the rolling-mill to the last press, are all worked out so as to be as near as possible automatic, and will reduce the entire complement of workmen, including heaters and boys, down to about ten or twelve, this number also covering the men who are handling and distributing the cold blanks previous to charging.

Patents for all this machinery have been applied for throughout the leading countries of the world, and most of them have already been granted. The industry represents mechanical problems absolutely unique, and of great interest to the engineering fraternity.

It is readily seen that in designing the different tools which make up this process, as well as in selecting the process itself, the main mechanical point in view has been to put as much work on the material as possible, and, when referring to the rim, it is perfectly natural that, in order to secure a homogeneous metal in this part of the wheel, it is of interest not to have too much material congregated at that particular place. From financial reasons one would arrive at the same result; because when considering the long life of a steel wheel, the increased first cost, with its compound interest, due to the carrying of this additional thickness for a number of years, will tend to counteract whatever benefits might be derived by having a little longer life.

It must also be remembered, that as the wheel is a solid finite and self-contained structure, with the rim rigidly connected to the web, it is possible to run with a thickness of rim that would be absolutely prohibitory with a tire, because in this latter case such a thickness, not being backed up by anything but its own inherent strength, would be stretched by the rolling action and become loose on its center.

While on the subject of finance, we might also refer to the cost of the steel-tired wheel. It must be understood that

the great underlying purpose for the introduction of the solid steel wheel is not directly one of competition with the center and tire construction; but is rather to be considered as a forward step in the freight trade. And with this in view, it is pertinent to say that should it even be impossible to claim the same amount of molecular work done on the metal, and also the same high excellence generally for the solid steel wheel as that which is claimed for the steel-tire construction, the difference, however, would be so small as to be of little account when considered in the light of the difference in the market prices of the two products.

In order to throw all possible light upon the effect on the metal as caused by this process of manufacture, and referring especially to the result of the kneading action in the rolling-mill, some experiments were made by Messrs. Williams, Brown & Earle, here in Philadelphia. A section of a wheel was given to the above firm to be highly polished, etched, magnified under a microscope and subsequently photographed. This magnification was about 50 to 1, and when making allowance for the magnification in the lantern the picture as thrown upon the screen will have been magnified in a ratio of about 1,500 to 1.

In order to form a better comparative opinion, pieces of the original and untreated blank were also investigated by the same concern and in a similar manner. The first two pictures, Plates VIII and IX, as thrown upon the screen, represent the original metal, the lighter being of a little denser structure than the darker one, though both show an entire absence of any uniformity or regularity in their molecular make-up. The next two, Plates X and XI, however, are taken from part of the rim of the finished wheel, and show a decided beneficial effect of the processes through which the wheel has passed. The last picture, Plate XII, is simply a photograph of the section which was treated as above, and as it was intended for mere experimental purposes it had never been coned, the web being left straight as it came from the mill. The tread shows cut marks where it was parted so as to furnish a smaller piece to facilitate handling in the microscopical and photographic apparatuses.

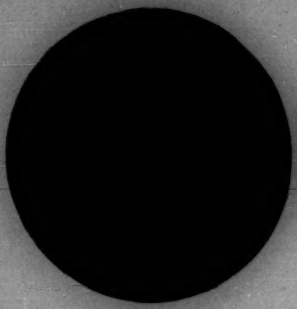


PLATE VIII.

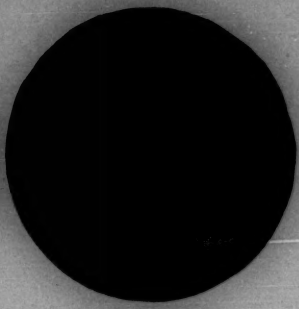


PLATE IX.

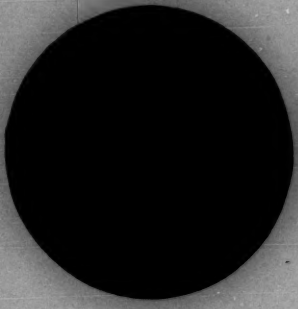


PLATE X.

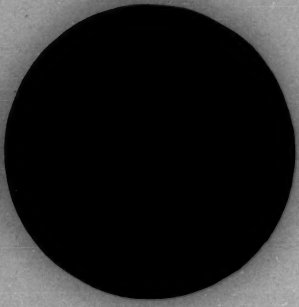


PLATE XI.

PLATE XII.

If it is of great importance to have a maximum amount of work done on the metal, it is even still more necessary to have a metal of the proper chemical composition. With this in view, inquiries were made in the engineering department of a large trunk line to ascertain which composition of tire produced the best result, realizing what was good for a tire would naturally be equally good for a solid steel wheel.

The mileage of several compositions were given, and the comparison between them resulted in a metal which is our present standard, and which runs about as follows:

| | |
|---|---|
| Carbon | about .7 per cent. |
| Manganese | .65 to .70 " " |
| Silicon | .3 " " |
| Sulphur and phosphorus, both below | .05 " " |

The physical test showed an elongation of about 13 per cent. in 2 inches, with a contraction of about 35 to 40 per cent., and an ultimate of about 125,000 pounds per square inch.

It may be of interest to know the practices in this line of foreign railways, and with that in view I have copied the following specifications from a trade catalogue published by one of the leading makers of steel tires:

ENGLISH PRACTICE.

CHEMICAL ANALYSIS.

| | |
|---|---|
| Carbon | .65 to .75 per cent. |
| Silicon | .20 to .25 " " |
| Phosphorus | under .05 " " |
| Manganese | .50 to .55 " " |
| Sulphur | under .045 " " |

PHYSICAL TEST OF STEEL OF ABOVE ANALYSIS.

| | |
|---|---|
| Tensile strength | 115,000 to 125,000 pounds. |
| Elastic limit | 55,000 to 60,000 " |
| Elongation | 10 to 15 per cent. |

RUSSIAN PRACTICE.

CHEMICAL ANALYSIS OF STEEL.

| | |
|---|---|
| Carbon | .50 to .60 per cent. |
| Phosphorus | under .05 " " |
| Silicon | under .25 " " |
| Manganese | .50 to .70 " " |
| Sulphur | under .05 " " |

PHYSICAL TEST OF STEEL OF ABOVE ANALYSIS.

| | |
|---|---|
| Tensile strength | 85,000 to 100,000 pounds. |
| Elastic limit | 45,000 to 50,000 " |
| Elongation in 2 inches | 17 to 22 per cent. |

## JAPANESE PRACTICE.

CHEMICAL ANALYSIS OF STEEL.

| | |
|---|---|
| Carbon | ·55 to ·65 per cent. |
| Silicon | under ·20 " " |
| Phosphorus | under ·05 " " |
| Manganese | ·55 to ·65 " " |
| Sulphur | under ·045 " " |

PHYSICAL TEST FROM STEEL OF ABOVE ANALYSIS.

| | |
|---|---|
| Tensile strength | 100,000 to 107,500 pounds. |
| Elastic limit | 50,000 to 55,000 " |
| Contraction of area | 20 to 29 per cent. |
| Elongation in 2-inch section | 15 to 18 " " |

## FINLAND STATE RAILWAYS.

CHEMICAL ANALYSIS.

| | |
|---|---|
| Carbon | ·50 to ·60 per cent. |
| Silicon | under ·20 " " |
| Phosphorus | under ·045 " " |
| Manganese | ·50 to ·60 " " |
| Sulphur | under ·045 " " |

PHYSICAL TEST FROM STEEL OF ABOVE ANALYSIS.

| | |
|---|---|
| Tensile strength | 92,000 to 100,000 pounds. |
| Elastic limit | 46,000 to 55,000 " |
| Elongation in 8 inches | 15 to 18½ per cent. |

Since the commencement of the agitation in favor of a solid forged, rolled steel wheel, the makers of the old cast-iron chilled product are brought face to face with a new innovation, and many arguments in favor of their own wheel and objections to this new one were advanced. It has been said that the introduction of the new steel wheel would force railroads to purchase and operate lathes to an extent that would be prohibitory in order to keep the steel wheel up to its standard. If the life of a steel wheel, with all its turnings, were no greater than the life of a cast-iron wheel, such arguments would be true. But if the time between the turnings of the steel wheel represents a mileage equal to that of a cast-iron wheel—and which it should do—

there would be no more dismantlings than what at present exists in ordinary car practice.

The above statement is based upon cast-wheel mileages of 70,000; but, as previously mentioned, the experience of at least one of the great trunk lines has cut this figure down to from 30,000 to 40,000 miles when operated in connection with the 100,000-pound cars, and in such a light the dismantlings for the steel wheel are of still less importance.

It has also been argued that good cast iron represents a metal for wheel purposes which is superior to steel, as it flakes less and, barring the question of strength, is a better all round metal when provided with a chilled rim.

I am not here to belittle the merits of the cast-iron wheel; on the contrary, its introduction, with its many magnificent qualities, enabled industrial progress to an untold degree; but, unfortunately, as competition became greater less care was used in the selection of the iron, and instead of having a metal of charcoal material, with an ultimate resistance of from 30,000 to 33,000 pounds, the wheels of to-day are made of iron ranging between 20,000 and 22,000, and at times hardly that. Such is the fact independent of any theory, and it is with this low-grade wheel that we have to deal.

I do not deny that it may properly be asked: If a better cast iron were substituted, what would be the result? The most pertinent reply that can be given to this query is, that all would have been well and the steel wheel would not have become a necessity, if the world had not seen the introduction of the steel car.

It goes without saying that when frogs and switches actually prohibit the increase of dimensions only one other alternative exists, namely: increase of tensile strength; and this last step in the evolution of the car wheel became, hence, a necessity and, as I also trust, has now become an accomplished fact.

Barring the records of individual railways, no concerted action has been taken in this country to keep and maintain a national record of the life and accidents to railway wheels. In Germany, however, an association was formed about ten

to fifteen years ago which included the German State Railways, the Austrian-Hungarian State Railways and a few other independent roads. This association has taken a great deal of care in the matter of wheels, comparing damages to different constructions as well as to different metals. There are, of course, no rolled steel wheels in their territory; but a number of cars, with a few locomotives and tenders, have been equipped with solid cast-steel wheels, and it is interesting to note the results, though their number is somewhat too small to form very conclusive opinions as to details.

During the years 1887 to 1896, the total number of tired wheels varied from 1,700,000 to 2,300,000, while the total number of solid steel wheels commenced at 340,000 and increased to 375,000, most of which latter were, as already mentioned, placed under cars generally carrying freight.

It was found that the percentage of loss—this includes cracks and fractures—in the steel-tired wheels was about ·18 per cent. in 1892, increasing up to ·22 per cent. in 1894 and 1895, while with the solid steel wheels during the same period, the total loss was about one-half of 1 per cent. In steel-tired wheels the relation of cracks to fractures was about 7 to 10, while with solid wheels the fractures were so rare that as a matter of comparison they can be ignored.

The above indicates clearly, from a point of general result, the superiority of the forged and rolled rim as compared to that of the coarse, crystalline cast metal.

The German report furnished some data on the question of temperature which may be of interest to our profession in this country.

The total damage done to steel-tired wheels during any one summer month, as compared to the month of January, is one to ten. This heavy mid-winter destruction lasts only for a short time, reaching its maximum during the month of January, while during the five summer months the minimum will remain practically constant. With solid steel wheels this relation was as one to four, showing the beneficial result of a solid web.

The German data indicated that the maximum damage

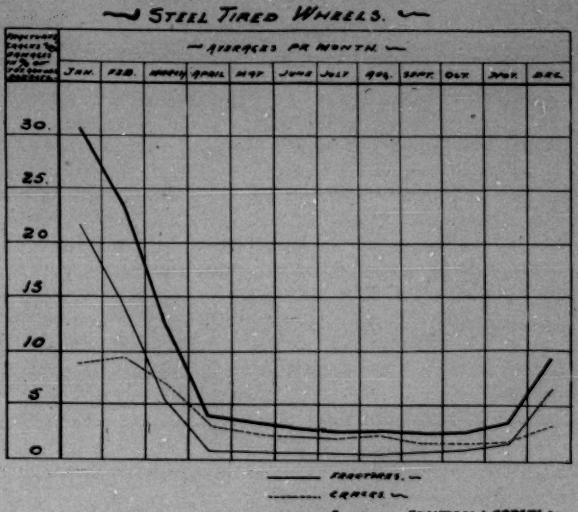



PLATE XIII.

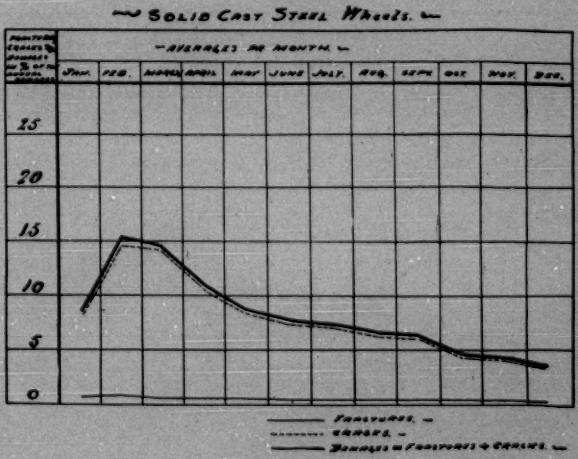



PLATE XIV.

Theoretical Diagram of a forged and rolled Steel Wheel.

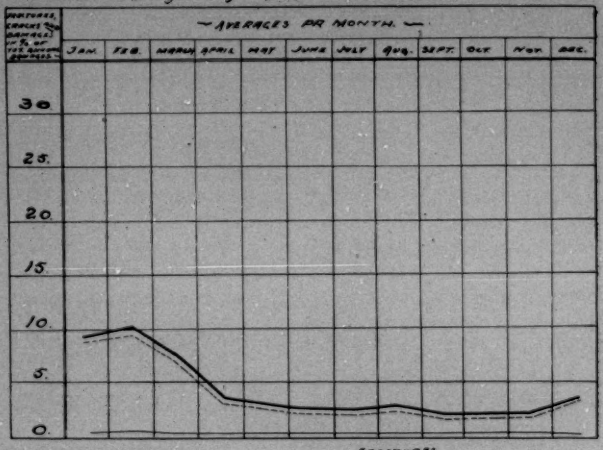



PLATE XV.

Diagram showing Comparison between Cast Steel, Steel Tired and Rolled Steel Wheels.

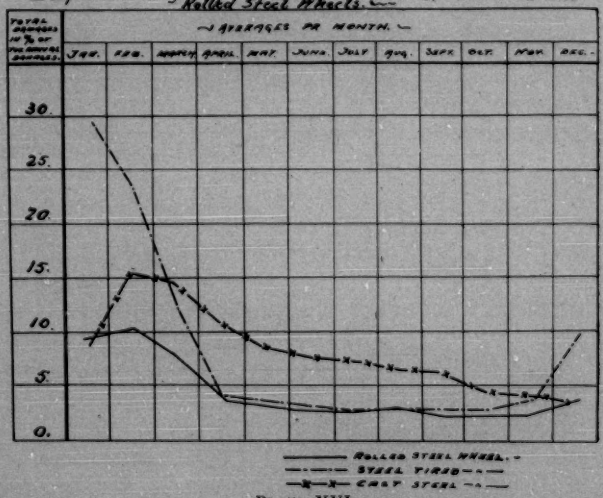



PLATE XVI.

was done with heavy tires, which I naturally suppose means that if a tire is imperfect the defects will develop shortly upon the wheel being placed upon the road. Illustrating this point, the following figures give a very interesting summary (the total damage done being considered as 100 per cent., including fractures and cracks, and the wheels representing the sum of both types, cast steel as well as tired).

Six per cent. of all the damage was done on mileages above 190,000; 30 per cent. was done on mileages between 100,000 and 190,000; 23 per cent. was done on mileages between 70,000 and 100,000, and 25 per cent. was done on mileages between 35,000 and 70,000.

The lessons derived from the above data, and as taught us by our German fellow engineers, would certainly seem to warrant us in drawing the conclusion that the solid forged and rolled steel wheel would have a rim which should possess very many of the meritorious qualifications of the steel tire, coupled with the advantages and the inherent strength afforded and shown by the web of the solid cast-steel structure.

The diagrams shown on Plates XIII, XIV, XV and XVI illustrate graphically what already has been said regarding temperature and wheel damages, cracks and fractures being shown separately.

The two first cards give directly the German results for steel-tired and cast-steel wheels, while the third card, representing the rolled steel wheel, is a theoretical construction based upon the German data for fractures with the cast steel wheel, and cracks with the steel-tired type. Such a combination ought to be one which this new construction should closely approximate.

The fourth card shows the total damages for all three kinds of wheels, and it is seen here that the solid wheel with the rolled rim shows the best efficiency.

In the history of the world industrial progress has been emphasized by certain landmarks, and I believe that among these epoch-making events those that refer to transportation on water or land are the greatest of all.

PLATE III.

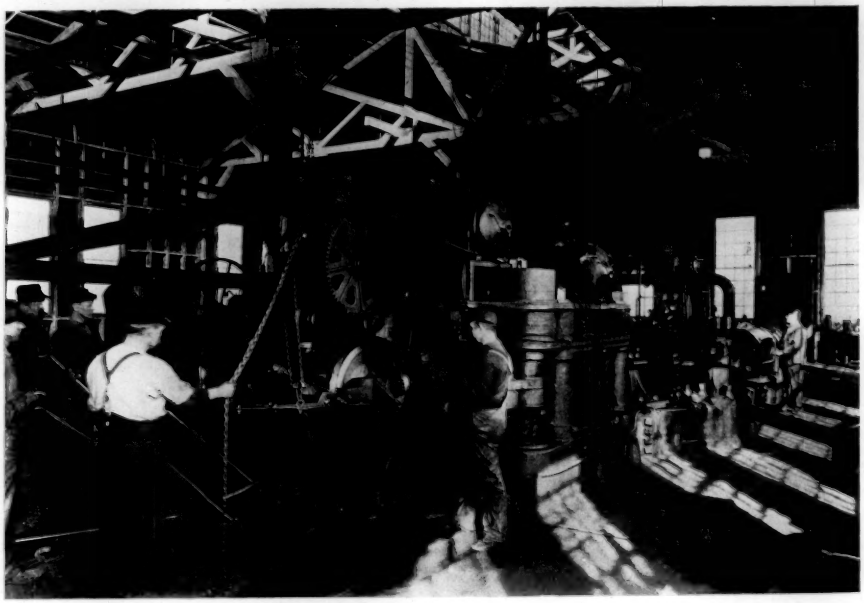


PLATE IV.

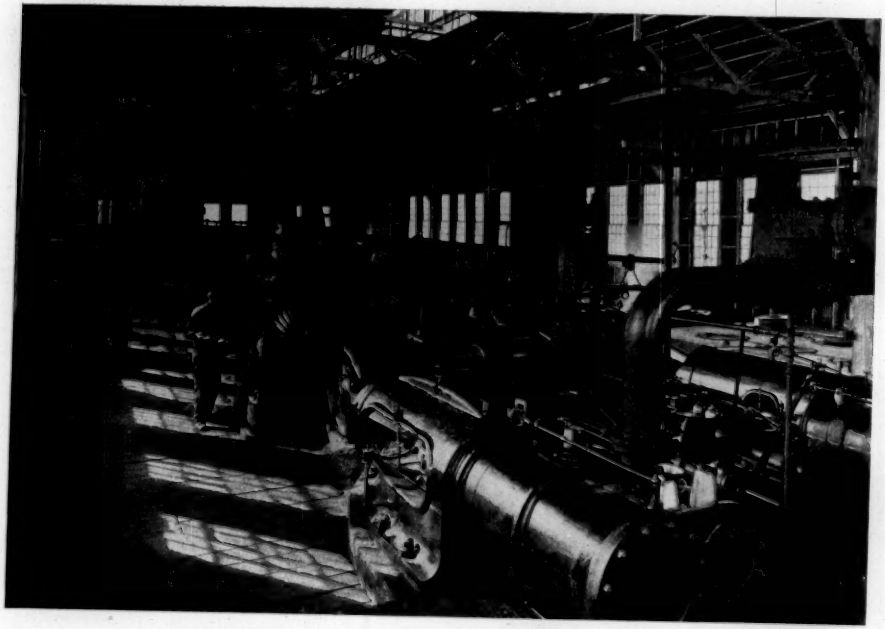


PLATE V.

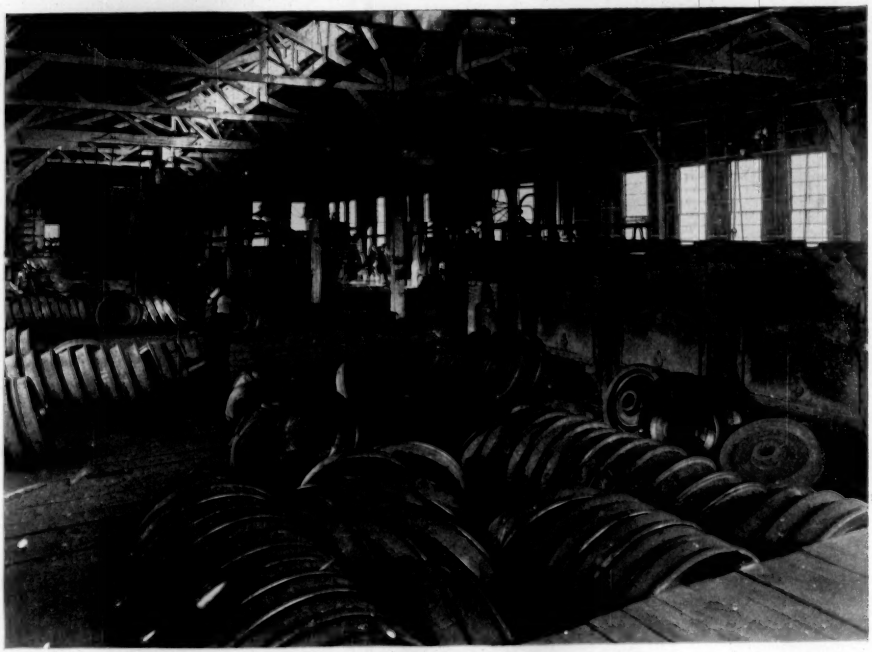


PLATE VI.

PLATE VII.

A few years ago, at a festive gathering of a number of remarkably able men, the question arose as to the relative importance, financially, industrially as well as ethically, of the leading inventions and discoveries recorded in the annals of history. The mariner's compass, the printing press, the steam engine, the laws for movement of matter, the discovery of the blood circulation, the anæsthetics, etc., were all reported in due order. The host, who was president of one of the greatest trunk lines of the world, remained silent. Finally, when one of his guests addressed him with a request to mention *his* choice amongst the great meritorious facts, his answer was prompt—"the flange of a car wheel."

DISCUSSION.

MR. ARTHUR FALKENAU:—I should like to know from Mr. Loss of what kind of material the punches are made.

MR. LOSS:—After a number of experiments we decided in favor of fairly hard cast iron as possessing the best average combination of durability and cheapness.

MR. W. VOLLMER:—I should like to ask Mr. Loss about the number of wheels at present in service. Also about their length of service and the mileage covered as well as their general efficiency.

MR. LOSS:—Last June about thirty experimental wheels were placed under locomotive tenders on different railways and for different purposes. Fast express trains, accommodation passenger trains (some of these latter running on mountain roads) and heavy freight were all included. From 25,000 to 35,000 miles, depending upon the character of service, was the average mileage before turning, and the general wear as taken from plaster casts was very good. The master mechanics handling the wheels have informed me that their behavior on the road or in the lathe in the machine shop was the same as that of an ordinary steel-tired wheel. We have lately started our works in Pittsburg, and during the last month from 900 to 1,200 additional wheels have been shipped and are daily being placed on the different roads.

MR. E. B. HALSEY:—What is the percentage of carbon used in the steel, and do you start from a blank or from blocks af steel cut from the ingot?

MR. LOSS:—The percentage of carbon is about .70, and the ingots are, as previously described, at present run separately. They are round, with varying thicknesses, and there is no doubt but what we shall shortly run them in multiples. Not being a mere steel casting, we use no sink-heads, but fall back upon the great pressures exerted upon the metal in the two presses and the rolling mill to solidify it. The pressure on the rim while rolled is equal to that existing in the largest tire-mill of to-day. The microscopic photographs show how well we have succeeded. It must be added, however, that a great deal of time and expense were bestowed on the subject of how to cast the ingots, resulting in the adoption of some very interesting methods. Our uniformity in product has been greatly advanced by this knowledge.

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## PRODUCTION OF ALUMINUM IN THE UNITED STATES IN 1902.

The production of aluminum in the United States during 1902 was approximately 7,300,000 pounds, as compared with 7,150,000 pounds in 1901, an increase of 150,000 pounds according to a report on the production of that metal by the United States Geological Survey. The Pittsburg Reduction Company, operating the Hall patents, continues to be the sole producer of aluminum in the United States, and, although the company is in patent litigation with the Cowles Electric and Smelting Aluminum Company, of Cleveland, its plants are being developed vigorously. It has in operation 11,000 horse-power at Shawinigan Falls, Quebec, a total of 16,000 horse-power, which is equivalent to a capacity of 4,500 tons of metal yearly, or more than the entire output of the rest of the world. The increased activity on the part of the company has been due to the fact that some of its fundamental patents will expire within a few years, and it is striving to perfect the methods employed to such an extent that after the expiration of the patents it will be in a position to compete successfully with new producers that may enter the field. Although the demand for aluminum has increased extensively, the price per pound continued practically stationary throughout the years 1901 and 1902. An international agreement between all of the aluminum producers has been drawn up and the price of ingot aluminum fixed for 1903, says the report. There are five companies in the world that produce aluminum at nine locations. For several years past the various companies have continued their secretive policy concerning the development of the industry, and practically nothing has been published in regard to modern improvements beyond the descriptions of patents, which have been granted mainly for the purification of bauxite—the chief raw material used in the manufacture of the metal.

# CHEMICAL SECTION.

*Stated Meeting, held Thursday, March 12, 1904.*

## Lutes.

By Samuel S. Sadtler.

The subject of plastic cements used to secure joints in vessels and connections (generally for temporary purposes), has been rather neglected in the chemical literature.

The success or failure of processes has very seldom depended upon the choice of satisfactory lutes, but great annoyance has been experienced in chemical works and manufacturing places where only unsuitable compounds have been found to seal apertures in nitric acid, chlorine, hydrogen sulphide and illuminating gas apparatus, and frequently considerable damage to property and loss of life has resulted.

I have, therefore, thought it advisable to bring together under the one title such formulæ as I know to be reliable, or have reasonable grounds for believing so, and hope they may be useful to others for laboratory or works' use.

The majority of these cements are useful for purposes of preventing the escape of inert gases, and others are suitable for more or less special purposes, where corrosive gases, etc., come in contact with them. Many of them had to be put down from memory, and therefore the product obtained in their use may be a little too stiff or too thin, but such deficiencies could be easily regulated.

Lutes always consist of a menstruum and dissolved or suspended solids, and they must not be attacked by the gases and liquids coming in contact with them. In some cases the constituents of the lute react to form a more strongly adhering mass.

The *conditions of application* are, in brief:

(*a*) Heating the composition to make it plastic until firmly fixed in place.

(*b*) Heating the surfaces.

(*c*) Applying the lute with water or a volatile solvent, which is allowed to volatilize.

(*d*) Moistening the surfaces with water, oil, etc. (the menstruum of the lute itself).

(*e*) Applying the lute in workable condition and the setting taking place by chemical reactions.

(*f*) Setting by hydration.

(*g*) Setting by oxidation.

These principles will be found to cover nearly all cases.

Joints should not be ill fitting, depending upon the lute to do what the pipes or other parts of the apparatus should do. In most cases one part of the fitting should overlap the other so as to make a small amount of the lute effective and to keep the parts of the apparatus rigid, as a luted joint is not supposed to be a particularly strong one, but rather one quickly applied, effective while in place and easily removed.

Very moderate amounts of the lute should be used, as large amounts are likely to develop cracks, be rubbed off, etc.

A classification may be given as follows:

(1) Plaster of Paris.
(2) Hydraulic cement.
(3) Clay.
(4) Lime.
(5) Asphalt and pitch.
(6) Resin.
(7) Rubber.
(8) Linseed oil.
(9) Casein and albumen.
(10) Silicates of soda and oxychloride cements.
(11) Flour and starch.
(12) Miscellaneous, including core compounds.

## I. PLASTER OF PARIS

is, of course, often used alone as a paste, which quickly solidifies, for gas and wood distillation retorts, etc., and similar places where quickness of setting is requisite. It is more often, however, used with some fibrous material to give it greater strength. Asbestos is the most commonly used material of these, as it will stand a high temperature. When that is not so important, straw, plush trimmings, hair, etc., are used as binders, while broken stone, glass and various mineral substances are used as fillers, but they do not add anything to the strength. These lutes seem to be particularly suitable for oil vapors and hydrocarbon gases.

Formulæ : (1) Plaster and water.
(2) " (wet) and asbestos.
(3) " " " straw.
(4) " " " plush trimmings.
(5) " " " hair.
(6) " " broken stone, etc.

## II. HYDRAULIC CEMENT.

Cement is used either alone or with sand, asbestos, etc., and I have been informed that these lutes are suitable for nitric acid. When used with substances such as resin or sulphur, it is probably employed because it is in such a fine state of division and used as a filler and not because of any powers of setting by hydration.

Formulæ : (1) Cement—neat.
(2) " and asbestos.
(3) " and sand.

## III. CLAY.

This most frequently enters into the composition of lutes as a filler, but even then the very finely divided condition of certain grades renders it valuable, as it gives body to a liquid, such as linseed oil, which, unless stiffened, would be pervious to a gas, the clay in all cases being neutral. Thus, for luting pipes carrying chlorine, a stiff paste of clay and molasses has been suggested by Theo. Köller in *Die Surrogate*, but I cannot recommend it, as it soon gives way.

Formulæ : (1) Clay and linseed oil.
(2) Same using fire-clay.
(3) Clay and molasses.
(1) Is suitable for steam, etc.
(2) For chlorine and
(3) For oil-vapors.

## IV. LIME

is used in the old lute known as putty, which consists of caustic lime and linseed oil. Frequently the lime is replaced by chalk and china clay, but the lime should be, in part at least, caustic, so as to form a certain amount of lime soap. Lime is also used in silicate and casein compositions, which are very strong and useful, but will be described elsewhere.

Formulæ : (1) Lime and boiled oil to stiff mass.
(2) Clay, etc., " " " "

### V. ASPHALT AND PITCH.

These substances are used in lutes somewhat interchangeably. As a rule, pitch makes the stronger lutes. Tar is sometimes used, but, because of the light oils and, frequently, water contained, it is not as good as either of the others.

Asphalt dissolved in benzol is very useful for uniting glass for photographic, microscopical and other uses. Also for coating wood, concrete, etc., where the melted asphalt would be too thick to cover well. Benzol is the cheapest solvent that is satisfactory for this purpose, as the only one that is cheaper would be a petroleum naphtha, and it does not dissolve all the constituents of the asphalt. For water-proofing wood, brick, concrete, etc., melted asphalt alone is much used, but when a little paraffin is added it improves its water-proofing qualities, and in particular cases boiled oil is also added to advantage.

Formulæ: (1) Refined lake asphalt.

| | | |
|---|---|---|
| (2) | Asphalt | 4 parts. |
| | Paraffin | 1 part. |
| (3) | Asphalt | 10 parts. |
| | Paraffin | 2 " |
| | Boiled oil | 1 part. |

Any of these may be thinned with hot benzol or toluol. Toluol is less volatile than benzol and about as cheap, if not cheaper, the straw-colored grades being about 24 cents per gallon.

Examples of so-called "Stone Cement" are:

| | | |
|---|---|---|
| (4) | Pitch | 8 parts. |
| | Resin | 6 " |
| | Wax | 1 part. |
| | Plaster | ¼ to ½ part. |
| (5) | Pitch | 8 parts. |
| | Resin | 7 " |
| | Sulphur | 2 " |
| | Stone powder | 1 part. |

These compositions are used to unite slate slabs and stoneware for domestic, engineering and chemical purposes. Various resin and pitch mixtures are used for these purposes and the proportions of these two ingredients are determined

by the consistency desired. Sulphur and stone powder are added to prevent the formation of cracks. Sulphur acting chemically and stone powder mechanically. Where the lute would come in contact with acid or vapors of the same, limestone should not be the powder used, otherwise it is about the best. Wax is a useful ingredient to keep the composition from getting brittle with age.

A class of lutes under this general grouping that are much used are so-called "Marine Glues." They must be tough and elastic. When used for caulking on a vessel they must expand and contract with the temperature and not crack or come loose.

Formulæ: (6) Pitch . . . . . 3 parts.
Shellac . . . . . 2 "
Pure crude rubber . . . . . 1 part.
(7) Pitch . . . . . 1 "
Shellac . . . . . 1 "
Rubber substitute . . . . . 1 "

These are used by melting over a burner.

### VI. RESIN, SHELLAC AND WAX.

A strong cement used as a stone cement is:

(1) Resin . . . . . 8 parts.
Wax . . . . . 1 part.
Turpentine . . . . . 1 "

It has little or no body and is used in thin layers.

For nitric and hydrochlorine acid vapors:

(2) Resin . . . . . 1 part.
Sulphur . . . . . 1 "
Fire clay . . . . . 2 parts.

Sulphur gives great hardness and permanency to resin lutes, but this composition is somewhat brittle.

Good water-proof lutes of this class are:

(3) Resin . . . . . 1 part.
Wax . . . . . 1 "
Powdered stone . . . . . 2 parts.
(4) Shellac . . . . . 5 "
Wax . . . . . 1 part.
Turpentine . . . . . 1 "
Chalk, etc. . . . . 8 to 10 parts.

For a soft air-tight paste for *ground-glass surfaces:*

| | |
|---|---|
| (5) Wax | 1 part. |
| Vaseline | 1 " |

(6) A strong cement, without body, for *metals* (other than copper or alloys of same), *porcelain* and *glass* is made by letting 1 part of finely powdered shellac stand with 10 parts of ammonia water until solution is effected.

## VII. RUBBER.

Because of its toughness, elasticity and resistance to alterative influences, rubber is a very useful constituent in lutes, but its price makes its use very limited.

Leather cement:

| | |
|---|---|
| (1) Asphalt | 1 part. |
| Resin | 1 " |
| Gutta percha | 4 parts. |
| Carbon disulphide | 20 " |

To stand acid vapors:

| | |
|---|---|
| (2) Rubber | 1 part. |
| Linseed oil | 2 parts. |
| Fire clay | 3 " |

Cement for mending rubber:

| | |
|---|---|
| (3) Rubber crude (sliced) | 1 part. |
| Resin | ½ " |
| | 8 parts. |

(4) *Plain Rubber Cement.*—Cut the crude rubber in small pieces and then add the solvent. Carbon di-sulphide is the best, benzol good and much cheaper, but gasoline is probably most extensively used because of its cheapness.

(5) To make corks and wood impervious to steam and water, soak them in a rubber solution as above; if it is desired to protect them from oil vapors, use glue composition. (See Section IX.)

## VIII. LINSEED OIL.

This is one of the most generally useful substances we have for luting purposes, if absorbed by a porous substance that is inert.

Formulæ: (1) China clay, Linseed oil } of general utility for aqueous vapors.
(2) Lime, Linseed oil } forming the well-known putty.
(3) Red or white lead and linseed oil.

These mixtures become very strong when set and are best diluted with powdered glass, clay or graphite. There are almost an endless number of lutes using metallic oxides and linseed oil. A very good one, not getting as hard as those containing lead, is:

(4) Oxide of iron and linseed oil.

## IX. CASEIN, ALBUMEN AND GLUE.

These if properly made become very tough and tenacious; they stand moderate heat and oil vapors, but not acid vapors.

(1) Finely powdered casein . . . . . 12 parts.
Slaked lime (fresh) . . . . . 50 "
Fine sand . . . . . 50 "
Water to thick mush.

A very strong cement for ground unions, stands moderate heat, as follows:

(2) Casein in very fine powder . . . . . 1 parts.
Rubbed up with silicate of soda . . . . . 3 "

A strong lute for general purposes, which must be used promptly when made:

(3) White of egg made into a paste with slaked lime.

A composition for soaking corks, wood, packing, etc., to render them impervious to oil vapors, is:

Gelatin or good glue . . . . . 2 parts.
Glycerin . . . . . ½ to 1 part.
Water . . . . . 6 parts.
Oil of wintergreen, etc., to keep from spoiling.

## X. SILICATE AND OXY-CHLORIDE CEMENTS.

For oil vapors, standing the highest heat:

(1) A stiff paste of silicate of soda and asbestos.

Gaskets for super-heated steam, retorts, furnaces, etc.:

(2) Silicate of soda and powdered glass, dry the mixture and heat.

Not as strong, however, as the following:

(3) Silicate of soda . . . . . 50 parts.
Asbestos . . . . . 15 "
Slaked lime . . . . . 10 "

Metal cement:

(4) Silicate of soda . . . . . 1 part.
Oxides of metal, such as zinc oxide; litharge, iron oxide, singly or mixed . . . . . 1 "

Very hard and extra strong compositions:

(5) Zinc oxide . . . . . 2 parts.
Zinc chloride . . . . . 1 part.
Water to make a paste.

(6) Magnesium oxide . . . . . 2 parts.
Magnesium chloride . . . . . 1 part.
Water to make a paste.

## XI. FLOUR AND STARCH COMPOSITIONS.

(1) The well-known flaxseed poultice sets very tough, but does not stand water or condensed steam.

(2) Flour and molasses, made by making a stiff composition of the two. This is an excellent lute to have at hand at all times for emergency use, etc.

(3) Stiff paste of flour and strong zinc chloride solution forms a more impervious lute, and is more permanent as a cement. This is good for most purposes, at ordinary temperature, where it would not be in contact with nitric acid vapors or condensing steam.

(4) A mixture of dextrin and fine sand makes a good composition, mainly used as core compound.

## XII. MISCELLANEOUS.

(1) Litharge.
Glycerin.

Mixed to form a stiff paste, sets and becomes very hard and strong, and is very useful for inserting glass tubes, etc., in iron or brass.

For a high heat:

(2) Alumina . . . . . 1 part.
Sand . . . . . 4 parts.
Slaked lime . . . . . 1 part.
Borax . . . . . ½ "
Water sufficient.

Of course, there are an almost infinite number of lutes or cements, but, classified as these are, they represent the largest number of them. The formulas that are not original, or were kindly given by friends, have been seen in the literature one here and one there, and laid aside for a year or more, so I can hardly give the credit for them that I would like to.

A class of mixtures that can only be classified according to their intended use are core compounds.

(1) Dextrin, about . . . . . 1 part
Sand, about . . . . . 10 parts
With enough water to form a paste.

(2) Powdered anthracite coal, with enough molasses to form a stiff paste.

(3) Resin, partly saponified by soda lye . . . . . 1 part
Flour . . . . . 2 parts
Sand (with sufficient water) . . . . . 4 "

(These proportions are approximate and the amount of sand can be increased for some purposes.)

(4) Glue, powdered . . . . . 1 part
Flour . . . . . parts
Sand . . . . . 6 " (with sufficient water).

For some purposes, the exact uses of which I am not familiar, the following mixture is used. It does not seem to be a gasket or a core compound:

(5) Oats (or wheat) ground . . . . . 25 parts
Glue, powdered . . . . . 6 "
Sal ammoniac . . . . . 1 "

I would say in conclusion that in any works or laboratory it is very good to have some such compositions made up ready to use without delay when wanted. Just which one, depends on the nature of the manufacturing or other work done.

I hope that some of the material contained in this paper may prove of benefit to some here present.

## IDEAL FUEL OF THE UNITED STATES.

Had Zoroaster pondered the problems of existence on the northwestern flank of the Appalachian Mountains instead of along the shores of the Caspian Sea, he would probably not have lacked the inspiration which gave to his philosophy a symbol of the eternal, for the everlasting fires of the Parsees might be more than duplicated by the springs of natural gas in the United States. Indeed, there is no country in the world which can compare with ours in its production of this perfect fuel. The combined production of all other countries is not over 1½ per cent. of the quantity produced in the United States, which had in 1902 a value of $30,867,668. A large portion of even the small outside production comes indeed from our neighbor, Canada.

Mr. F. H. Oliphant's report on the "Production of Natural Gas in 1902," which the United States Geological Survey has just published as an extract from its annual volume of "Mineral Resources," is full of interesting details about the history, output, value and uses of this most satisfactory combustible.

The records of early investigators and missionaries show that natural gas has been known to exist in natural springs in western New York, western Pennsylvania, central West Virginia, northeastern Kentucky and southeastern Ohio for at least 250 years. In 1775 General Washington visited a burning natural gas spring on the northeast bank of the Great Kanawha River in West Virginia, a few miles east of the present city of Charleston. He was so impressed by the phenomenon that he pre-empted an acre of land surrounding the spring and dedicated it to the public forever.

The earliest economic use of natural gas in this country was probably made in lighting the village of Fredonia, Chautauqua County, New York, in 1821. The existence and utilization of this gas at Fredonia became widely known, both in this country and abroad, and excited the liveliest interest among scientific men. So little suspected, however, was the presence of the enormous volume of gas since developed that, when it was further explored, it was pronounced "unparalleled on the face of the globe," and Humboldt is quoted as declaring it the eighth wonder of the world.

Its introduction into commercial use was slow, but after its value was fully demonstrated there was a rush of capital, and a large amount of money was invested in gas territory, gas wells, and pipe lines. Then followed a period of reckless consumption and appalling waste. Many of the original fields were rapidly depleted of their high pressure. Not until it was fully realized that a large proportion of the natural supply had been consumed and dissipated by the extravagant methods in use were improved means adopted for holding back the gas in the original rock reservoirs. This was done by shutting off the wells, by cutting off all blow-off standpipes and escapes, by improving the joints of the pipe lines, and by the more economical consumption of the gas.

This economy came rather late, but enough of the original supply remains, stored principally in the deep and prolific sands of northern and southwestern Pennsylvania and western West Virginia, to furnish this ideal household fuel for many years to come. What may be done by deeper drilling and improved methods to prolong its use indefinitely is yet unknown.

# CHEMICAL SECTION.

*Stated Meeting, held Thursday, January 28, 1904.*

## Early Chemical Manufactures.—A Contribution to the History of the Rise and Development of Chemical Industries in America.

By M. I. Wilbert,
Member of the Institute.

Chemical industries play such an important part in supplying the needs and wants of our every-day life that we, at times, can hardly realize that the time was, and not so long ago, when in the whole length and breadth of this great land there were practically no manufactures of this kind. It is now not much more than a century ago since the manufacture of chemicals, as such, was commenced in this city, and this, so far as known, was the first in the country. In a short sketch of this kind, it would, of course, be practically impossible to describe, or even enumerate, all of the concerns that have been interested in the manufacture of chemicals since the first introduction of the industry in America. We will content ourselves, therefore, by attempting to call your attention to some of the varied and interesting materials that are available for an extended sketch, or a history, of this subject.

Chemical processes enter so largely into manufactures of all kinds that it is at times difficult indeed to draw a distinctive line between what may or may not properly be classed as chemical products. For this reason we will confine ourselves, as much as possible, to the enumeration of substances of a distinctly chemical nature that are or may be used in other arts and manufactures or in the practice of medicine.

There is no distinct evidence that the aboriginal inhabitants of any portion of North America produced or used chemical substances as such. A number of these inhabit-

ants did make use of chemical processes in the making or manufacture of pottery, paper, paint pigments and fermented drinks; but even these were produced in limited quantities, and there was nothing like a general or widespread industry.

Chronologically, then, the earlier efforts at the manufacture of chemical substances may readily be divided into three distinct periods.

(1) The colonial period, from the first settlement of the country, to the time of the revolutionary war.

(2) The period from the revolutionary war to the war of 1812.

(3) The period from the war of 1812 to the rejuvenation of interest in scientific pursuits, about the middle of the nineteenth century.

The chemical manufactures of these several periods were quite distinctive. In the first period the manufactures, in the chemical line, were confined to the production of potashes and lime, with stray experiments and trials in the manufacture of salt, saltpeter and gunpowder.

In the second period, largely, if not entirely, brought about by the exigencies of war, manufactures of salt and gunpowder were established as permanent industries, while the manufacture of paint pigments and a number of chemical substances was tentatively established in Philadelphia.

In the third period, due directly to the war of 1812 and the commercial restrictions which preceded it, we have the introduction of the manufacture of sundry chemicals for technical and medicinal purposes.

So far as is known, the first chemical substances made in America were produced in the Jamestown Colony, where as early as 1608 the manufacture of pot- or soapashes was tried, and the resulting product, with samples of pitch, glass and clapboards, was sent to England by these first colonists.

It would appear, therefore, that chemical substances were among the first exports of manufactured articles from what is now the United States.

While there is little or no evidence that the manufacture of potashes was entered into extensively for the next two or

three decades, pot- and pearlashes did, in later periods, constitute a very important article in the exports of nearly all of the English Colonies in North America.

In this connection it might be of interest to mention that there are a number of records of premiums having been offered and awarded, by both home and colonial societies, for the encouragement of the industrial arts, for the largest and best production of pot- or pearlashes.

Gabriel Thomas, in his account of Philadelphia and the province to the year 1696, mentions potashes among the list of exports, and in later years, even down to the opening decades of the nineteenth century, the making of potashes constituted one of the more important industries of Philadelphia, a number of manufacturers of this product being located along the Delaware front.

During the colonial period potash works were numerous throughout the American colonies. In Massachusetts alone, toward the end of the eighteenth century, it was estimated that they numbered fully 250. Many of these establishments were being conducted on a large scale and were quite successful. The average exports of pot- and pearlashes from the United States at the beginning of the nineteenth century, according to the "Statistical Annals of the United States from 1789 to 1818," by Adam Seybert, was about 6,000 tons annually.

The manufacture of soap was probably one of the first uses for which the alkali was employed in the colonies. Soap boiling as a commercial venture was introduced at quite an early date. The father of Benjamin Franklin, Josiah Franklin, was probably one of the first to engage in it as a business. Josiah Franklin, a dyer by trade, came to Massachusetts about 1682 and engaged in business as a tallow-chandler and soapboiler.

The earliest mention of the manufacture of lime is probably that in the records of Providence, Rhode Island, where, in 1662, a Mr. Hatchet applied for liberty to burn lime and to take stone and wood from the public commons for the purpose.

It is quite probable, however, that lime had been burned,

even before this date, from shells that were found in great profusion along the coast. This shell lime was the principal dependence in several of the colonies until after the beginning of the eighteenth century.

In or near Philadelphia, lime is said to have been made from limestone, about 1681, at Mountjoy, a manor that belonged to Letitia, the daughter of William Penn.

Common salt, one of the prime necessities of the European, was first made in the Virginia Colony some time previous to 1620. These earlier works were allowed to fall into decay, but were rebuilt, and in 1633 there is a record of salt having been made in appreciable quantity. In that year a considerable amount of salt was exported to Massachusetts for use in the fisheries.

About 1623 salt works were erected by a company on a site in or near the present city of Portsmouth, N. H. Several other attempts at the manufacture of salt from sea water are recorded, but as none of these proved successful or were continued for any length of time, it will not be necessary to enumerate them further.

It was not until the time of the Revolution that the manufacture of salt was established as a permanent industry.

The salt springs of Central New York were first discovered about 1654 by Père Le Moyne, a French Jesuit. They were not readily accessible, however, and were not developed in a commercial way until some time after the American Revolution, or nearly 150 years after their discovery.

The interruption of foreign trade by the Revolutionary War led to the organization of a great number of small establishments for the manufacture of salt all along the Atlantic seaboard from Cape Cod to Georgia.

One of the more successful of these early salt manufactories was established on Quivet Neck, in the town of Dennis, Barnstable County, Mass., by John Sears, a mariner. This pioneer salt maker had probably become acquainted with the salt works along the Mediterranean or in the West India Islands and conceived the idea of making salt by the use of solar heat exclusively. This establishment, dubbed

by the natives "John Sears' folly," was the first of a number of works in Barnstable County, where the salt industry subsequently developed into a large and flourishing business, in the early decades of the nineteenth century.

During the Revolution common salt was the most prized of all commodities. The ordinary product that before the war sold for 2 shillings a bushel rapidly increased in price, and in 1776 was not to be had for 25 shillings a bushel.

Philadelphia, with the surrounding country, was severely affected by this scarcity, and increase in the price, of salt, and several attempts were made to establish salt works along the New Jersey coast. One of these, at Tom's River, was conducted for a time by Thomas Savage, and was, with a number of others, burned or demolished by the British troops during the war.

For some time after the Revolution, salt in the country west of the Allegheny Mountains was worth "a cow and a calf" a bushel. This was the prevailing price until some time after 1790, when salt from the Onondaga salines was introduced and this, for a number of years, supplied a large portion of the western country. As late as 1815 salt in Cincinnati was quoted at from $3 to $5 a bushel, while the earlier settlers were obliged to pay as much as $7 and $8 for a very inferior quality. Salt was made on the Wabash, in the Indiana Territory, early in the nineteenth century.

The manufacture of salt was also commenced in Western Pennsylvania about 1812 and this led to the establishment of a number of similar works in Southern Ohio and also in what is now West Virginia.

Another substance of a chemical nature that was absolutely essential to the colonists was gunpowder. The manufacture of this product was attempted at an early date, the first available record being in 1639, when Edward Rawson was granted 500 acres of land at Pecoit, Mass., to aid him in developing the manufacture of this very essential article.

In 1642, to promote and perfect the making of gunpowder, it was directed that every plantation within the Colony of Massachusetts should erect a suitable house to make salt-

peter. There are several additional records of early powder mills in Massachusetts, as well as in other Colonies, but none of them appear to have been continued for any length of time.

The exportation of powder and its materials from England was prohibited by an order in Council, of October 19, 1774, so that the American Colonies were made dependent on other sources for their supply.

The Continental Congress, in various ways, encouraged the erection of powder mills, and also the production of nitrate of potash. Congress, in 1775, published a manual giving directions for making saltpeter, and about the same time the "Committee of the City and Liberties" erected a large saltpeter works on Market Street for the double purpose of making saltpeter and also to instruct such as were willing to engage in the making of this very necessary article for the powder mills.

Similar works were also erected in Boston by Dr. Whitaker and by others in different places.

As a further source of supply the ground about the tobacco warehouses in Virginia and Maryland was dug up and leached out and considerable quantities of potassium nitrate were obtained in this way.

In this same connection it may be interesting to note that, during the war of 1812, a very large amount of saltpeter was obtained by leaching out the deposits in the limestone caves of Kentucky.

The manufacture of gunpowder was very extensively carried on during the Revolution in nearly all of the American Colonies. A very large proportion of this powder, however, was made in Pennsylvania. Philadelphia was among the first places in which powder mills were successfully operated.

Early in the Revolution a public powder mill was established in or near Philadelphia by the Assembly, while Congress opened, and for some time operated, what was known as "The Continental Powder Mill." Congress also offered advances to such persons as would be willing to establish powder mills within fifty miles of the city of Phil-

adelphia, and this offer was taken advantage of by many who subsequently supplied a liberal proportion of the powder used in the Continental Army.

Probably the oldest of the still existing powder mills was established about 1802 by Eleuthere Irene Du Pont, who came to this country from France in 1799. Du Pont established his first mill on the Brandywine, about four miles above what was then the village of Wilmington. Having had some experience in the manufacture of gunpowder in France and being able to produce a quality much superior to that in use in this country at that time, he soon established a business that developed into the most extensive of the kind in the country.

Philadelphia and Philadelphians have taken a very important part in the origin and development of chemical industries of all kinds. Probably the first to inaugurate the manufacture of chemicals, as such, in this country, was the firm of Christopher, Jr., and Charles Marshall, sons and successors of Christopher Marshall, an early druggist and one of the original "fighting Quakers" of Philadelphia, this firm had, as early as 1786, entered quite extensively into the business of making muriate of ammonia and Glauber's salt. The factory is described by Watson, in his "Annals of Philadelphia," as being a grim and forbidding-looking building on Third Street near the stone bridge over the Cohocksink Creek. This firm is said to have developed an annual output of upwards of 6,000 pounds of muriate of ammonia; quite an achievement for that time.

The manufacture of white lead was commenced by Samuel Wetherill, another Philadelphia druggist, about 1789. This business rapidly developed, despite the reputed opposition of English manufacturers. In 1809 extensive works were opened at or near the corner of Broad and Chestnut Streets. These being destroyed by fire a new plant was erected at the corner of Twelfth and Cherry Streets. This for a number of years was the site of the now very extensive manufacture of white lead and color pigments. After the enforcement of the Embargo Act, which preceded the war of 1812, a number of manufacturers en-

gaged in the manufacture of white lead and paint. Among these was Dr. Joseph Strong, who undertook the manufacture of various lead pigments at his laboratory, 485 North Third Street, opposite the Globe Mills. Joseph Richards, about 1812, established a factory on Race Street near the Schuylkill River. This was later removed to Pine Street above Broad, where he was succeeded by the two brothers, Mordecai and Samuel N. Lewis, who developed a large and lucrative business. Harrison Brothers were also among the first to engage in the manufacture of white lead. The founder of this firm, John Harrison, was probably the first to manufacture sulphuric acid in the United States.

Sulphuric acid has been, quite properly, called the basis of all chemical industries. It is for this reason that the credit for establishing chemical industries in the United States is frequently accorded to John Harrison, a Philadelphia druggist, who, about 1793, was the first to produce sulphuric acid in a commercial way.

Mr. Harrison sold out his drug business in 1806 and devoted himself exclusively to the manufacture of acids and chemicals. It was not long before others followed in the manufacture of the heavy acids. In Philadelphia, Farr & Kunzi were probably the first to follow the example of Mr. Harrison. They engaged in the manufacture of sulphuric acid about 1812, and were soon followed by Wetherill & Brothers, who opened a manufactory of oil of vitriol on the east bank of the Schuylkill River. Mr. Harrison was also the first in this country to have and to use a platinum still. This still was constructed by a Dane, Erick Bollman, who appears to have been a man of more than ordinary attainments and who was particularly well versed in metallurgy.

Charles Lennig is said to have been the first to enter into the manufacture of sulphuric acid on a large scale, and he was also the first to use platinum stills so arranged that the operation was practically continuous and automatic.

Charles Lennig was the founder of the well-known firm of Nicholas, now Charles, Lennig & Co. He began operations about 1831, and in addition to the heavy acids made a number of chemicals for the use of textile manufacturers and dyers.

The development of the textile industry in different sections of the New England States created considerable demand for a number of chemical substances, particularly sulphuric and muriatic acids and the salts commonly used in bleaching and dyeing. This demand brought about the establishment of chemical manufactures in the same locality. The plants at Roxbury and Salem, Mass., were probably among the first to be established in New England.

The first to manufacture acids and heavy chemicals west of the Allegheny Mountains was Eugene Graselli, who built a large laboratory and established a successful business some time between 1820 and 1850. He was followed some years later by Harwood & Marsh, also in Cincinnati. Other manufacturers followed, and about the year 1850 sulphuric acid was being made in Pittsburg, Pa.; Steubenville, O.; St. Louis, Mo.; New Orleans, La., and probably in other towns and cities west of the Allegheny Mountains.

The commercial restrictions that preceded the war of 1812 were the direct cause of firmly establishing a number of chemical manufactures as permanent industries.

Among the chemicals, the manufacture of which was introduced about this time, is copperas. This was first made at Strafford, Vt., about 1810, from native pyrites. Copperas was also made at a very early date at Pequannock, Morris County, N. J., and about the year 1811 works were opened on the Magothy River, Md., by Richard Colton and others. About three years later the manufacture of alum was added and the works were then put in charge of Gerard Troost, a Hollander by birth, who, though undoubtedly a poor business man, was a scientist of exceptional attainments and abilities. Gerard Troost was one of the founders of the Academy of Natural Sciences of this city. He was an able geologist, an excellent chemist and an efficient teacher. He was, about 1823, professor of chemistry at the Philadelphia College of Pharmacy. Later, he was for some years one of the professors in the University of Nashville and also served as geologist to the State of Tennessee.

Epsom salt is said to have been made in this country as early as 1790 in the town of Bridport, Addison County,

Vermont, from the waters of a mineral spring discovered by the Rev. Sylvanus Chapin. The same substance was also made at quite an early date in or near Baltimore, Md., from native magnesite, while in Barnstable County, Mass., Epsom and Glauber's salt were early obtained as by-products in the manufacture of salt.

In the first copy of the *American Journal of Pharmacy*, then called the *Journal of the Philadelphia College of Pharmacy*, published in 1825, Daniel B. Smith describes at some length the details of the manufacture of Epsom salt in Barnstable County, Mass. The credit for developing this particular portion of the industry is said to be due to the Rev. Mr. Briggs, who is described as being an industrious and ingenious chemist.

The Epsom salt of that early day was quite different in appearance, and also in price, from what we would expect at present. It was usually wet and soggy, always impure and, not infrequently, mixed with, or sometimes substituted by, Glauber's salt. The difference in the price, in the early decades of the last century, made this quite a profitable form of adulteration. Epsom salt selling regularly for fifteen cents a pound, while Glauber's salt could be had for from two and a half to three cents a pound.

Chromates were probably first made in Baltimore, though as early as 1816 a Mr. Wesener, a German chemist, had established himself in Philadelphia, in the neighborhood of Broad and Cherry Streets, where he made chrome salts and chrome pigments in considerable quantities. Being nearer the source of supply of the raw material, the Baltimore manufacturers had a decided advantage, so much so that before the middle of the last century the business had drifted back to that city.

Among the earlier manufacturers of chrome salts in Baltimore were Isaac Tyson & Son and William Davidson & Co. This latter firm also made ferrocyanide salts and probably other heavy chemicals.

The manufacture of ferrocyanides was also carried on quite extensively in Philadelphia, and it may be interesting to note, in this connection, that it was in the manufacture

of ferrocyanide of potash that the first attempts were made to utilize atmospheric nitrogen by combining it with carbon at very high temperatures. The manufacture of ferrocyanides was, at a later period, gone into quite extensively at Cincinnati, Ohio, where the large pork-packing establishments insured an ample and cheap supply of organic materials necessary in its manufacture. About 1850, one firm alone in Cincinnati produced annually upwards of 60,000 pounds of prussiate of potash.

The manufacture of bromine, as a by-product in the production of salt, was commenced at the salt springs near Pittsburg about 1845, and soon assumed enormous proportions.

Soda salts, particularly soda ash, sodium carbonate and also sodium bicarbonate (the latter first known as soda salæratus and later as baking soda), have developed into an enormous and highly specialized branch of chemical manufactures.

Among the first in this country to manufacture soda ash on a large scale was the Pennsylvania Salt Company, at Tarentum, near Pittsburg. This company, although it has probably developed along different lines from what was at first anticipated, has amply verified a prophecy, made more than fifty years ago, that it would become one of the largest chemical works in the Union.

John Dwight and Austin Church began the manufacture of soda salæratus about 1846. They were eminently successful and practically controlled the American market for sodium bicarbonate for a number of years. The rapid development in the manufature of this particular product is well illustrated by a comparison of prices. In 1820, what was then called supercarbonate of soda, was listed and sold regularly for $1.25 per pound, while in 1850 the same amount could be had, in regular trade, for 4 cents.

Previous to 1850, and for some time after that, Philadelphia was the acknowledged center for the manufacture of chemicals for medicinal use. One of the first to engage in this branch of chemical manufactures was Dr. Adam Seybert, a graduate of the Medical Department of the University

of Pennsylvania, class of 1793. He was also one of the more prominent members of the Philadelphia Chemical Society. This society, as is well known, took an active part in the development of the mineral resources of the United States.

In 1801, Dr. Seybert established a chemical laboratory at No. 168 North Second Street, where he is said to have made the first mercurials made in this country.

The first to follow him in this line was John Shinn, Jr., who, about 1810, established a laboratory at No. 282 North Third Street for the manufacture of calomel, corrosive sublimate and a number of other chemicals for medicinal and technical uses.

About this same time (1810) Innes & Robertson established a laboratory in Elizabethtown, New Jersey, where they made aqua ammoniæ, sulphuric ether, benzoic acid, and, some time later, added a full line of mercurials and other medicinal chemicals.

About 1811, Dr. Gerard Troost, who has been mentioned before in this sketch, in company with his brother, Benoit Troost, began the manufacture of a variety of chemicals for medicinal use in a laboratory on Coates Street (now Fairmount Avenue), in this city.

The Wetherills were also manufacturers of a line of chemicals in their extensive laboratory at the corner of Twelfth and Cherry Streets.

Farr & Kunzi began the manufacture of chemicals about 1818. Abraham Kunzi, a Swiss by birth, retired in 1838, and the senior partner, John Farr, who had been born and brought up in England, associated with himself Thomas H. Powers and William Weightman, two young Philadelphians, who had been in the employ of the firm for some time. The new firm name was John Farr & Co. This was later changed to Farr, Powers & Weightman, and, on the death of the senior partner in 1841, the firm name was again changed; this time to the still existing title—Powers & Weightman. This firm, for a number of years, was considered to be one of the largest general chemical manufacturing concerns in the United States, and it still holds an enviable reputation for the quality and reliability of its manufactures.

George D. Rosengarten and Charles Zeitler, as Rosengarten & Zeitler, began the manufacture of chemicals in St. John Street, Philadelphia, about 1822. They were among the first to manufacture the alkaloids of cinchona and opium in this country. Zeitler, while admittedly a very able chemist, appears to have been rather eccentric in his ways. He withdrew from the firm about a year later and Mr. Rosengarten continued the business alone until 1834, when he associated with him N. F. Dennis, a French chemist of considerable ability. The firm continued as Rosengarten & Dennis until 1855, when the junior partner withdrew and the firm name was changed to its present style, Rosengarten & Sons, the laboratory, about the same time, being removed to its present location at Seventeenth and Fitzwater Streets. There were, of course, a number of other manufacturers of medicinal chemicals, but the majority of them have long since specialized into one or two particular lines or have discontinued business. One of the latter, Charles Ellis & Co., were at one time extensive manufacturers of chemicals. They were the successors of Christopher Marshall, who, in turn, was probably the first druggist, with any appreciable amount of chemical training, to settle in America.

Any historic account of the development of the chemical industries in America would be incomplete without at least some reference to the rise and development of the teaching of the technical side of chemistry.

The first systematic attempt to teach the principles of chemistry was made in 1765 in connection with the medical department of the, then, College of Philadelphia. The first teacher of this branch of science was John Morgan, the founder of the Medical School.

No separate chair of chemistry was instituted until 1769, when Benjamin Rush was appointed professor of chemistry in the same school.

The first school to institute a chair of chemistry as part of a collegiate education was the College of New Jersey, now Princeton, where John MacLean taught chemistry some years before the beginning of the nineteenth century.

Popular lectures on chemical subjects were given in

Philadelphia as early as 1807, when Dr. Joseph Parrish, then quite a young man, commenced a series of public lectures on chemical subjects. To Dr. Parrish must be given the credit of establishing a system of instruction, by means of popular scientific lectures, that has done much to keep the citizens of Philadelphia in touch with modern progress.

Probably the first institution to take up and elaborate on this idea of popular instruction was the Franklin Institute. This institute, from its foundation, has always adhered to the practice of giving popular scientific lectures. The first course of these lectures was given in the old Academy Building, the original home of the College of Philadelphia, and later in Carpenters' Hall, where, also, was held the first exhibition ever given under the auspices of the Institute. On the completion of its own building the lectures were given in its own, now venerable, hall.

Altogether, the Franklin Institute has contributed no unimportant part to the progress of chemical industries in the United States. The popular lectures on chemistry no doubt tended to awaken a lively interest in the subject, while the, at first, annual, and later, periodical exhibitions, in connection with the reports and other papers published in the *Journal* of the Institute, have served to collect and give information of great value to the pioneer manufacturer.

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## Section of Photography and Microscopy.

*Stated Meeting, held Thursday, October 29, 1903.*

# Improved Methods of Producing Color Values for Monochrome and Three-Color Printing.

By John Carbutt,
Member of the Institute.

In bringing to the notice of the members of the Franklin Institute improved methods of producing color values for monochrome and three-color printing we will first briefly trace the origin and growth of what is now recognized, from the scientific and commercial standpoints, as one of the most wonderful achievements in photography.

In 1861 James Clerk-Maxwell first experimented with three-color photography, and the color curves plotted by him are the base on which the results of to-day are obtained. But at that date there were no color sensitive plates to be had, and the subject lay in abeyance until the late Dr. Herman Vogel, of Berlin, in 1873 found by the addition of certain dyes to collodion (principally of the eosine group) a better rendering of the greens and yellows was obtained. Captain Waterhouse also experimented on the same lines. In 1878–9 Mr. F. E. Ives produced very red sensitive collodion plates by the use of chlorophyll as a sensitizer. The late Mr. Carey Lea also made extensive experiments with salts of chlorine to produce color values, but, owing to the slowness of collodion and the long exposure required to reproduce the red, the securing of color values by photography was only made possible on the advent of the more sensitive gelatine dry plates. In 1883 Tailfer and Clayton, of Paris, brought out a dry gelatine plate color sensitized with eosine, and the same was introduced commercially in London in 1884 by Mr. J. B. Edwards. Learning of this through the British Photographic Journals, I took up the study of the subject, and in 1885 commenced the manufacture of orthochromatic plates. These plates,

with the aid of a yellow screen for landscapes, flowers, etc., and an orange screen for copying paintings, produce satisfactory color values, including blue, green, yellow and orange, but lack the power to reproduce red, unless a very dark red filter is used, entailing a very protracted exposure.

It is a little over two years since I commenced experimenting to produce a color-sensitive plate that would be sensitive normally to all colors of the spectrum. I found little difficulty in preparing a plate well sensitive to orange and red, but the spectrum test showed lack of sensitiveness to the blue green, and it took a great many experiments and combinations of dyes to overcome lack of sensitiveness in the line "F" of the spectrum, and which I finally achieved, as will be shown on the screen later. This plate I named "Polychromatic," as it is sensitive to all colors of the spectrum—from blue to red. Then came the necessity of suitable light filters to use with the polychromatic plate, so as to produce the Clerk-Maxwell color curve on the three respective negatives, from which three positives—either by contact with a medium-rapid dry plate or in the camera, and the final negatives taken through the ruled line screens of Levy's (usually by the wet collodion process)—are made. And from these negatives the three half-tone copper-plates are produced. Now while the Clerk-Maxwell method is quite correct in theory, the practical three-color workers find it too exacting to produce printing plates requiring little or no re-etching; consequently they (the etchers) prefer a more distinct separating of the color values than an over-lapping curve, as will be seen in the spectrum image taken through three-color filters on the polychromatic plate. To meet this requirement I am making color-sensitive plates in two series, "C" and "D." The C plate is strongly red sensitive with green subdued, while the D plate is strongly green sensitive with red, orange and yellow subdued. The advantage is that a much lighter red filter can be used with the C plate to secure the red for blue printing plate, and a lighter green with the D plate for the red printing plate, and time of exposure reduced with both, while the C plate can be used with the violet-blue filter

for yellow printing plate, and as some three-color printers prefer a trace of red in the yellow plate, the C plate and a violet-blue filter accomplish this. Besides the method here outlined, which requires the use of nine plates, a more direct method is now being practised, both in Europe and America, both with collodion and gelatine plates, by what is called "the direct method;" that is, the exposure is made through the light filters and the ruled screen, producing at one operation, when carefully carried out, the results obtained with three original negatives, then three positives and the final wet-plate negative through the ruled screen.

Three-color photography is now of wide application, both in the reproduction of works of art and manufactured articles. American three-color printers are in no way behind in their productions in comparison with foreign three-color printers. Philadelphia has several such establishments. A few examples of their work I have brought for your inspection.

I would call you attention to the series of prints representing the stages of three-color printing by which the final delicate and beautiful results are obtained. First print in yellow ink, next in red, then in blue, showing the shades of ink used. Then the red is printed over yellow, and finally the blue. The change, making the complete print, seems almost magical.*

## Correspondence.

### CONTROLLING THE FLOODS OF THE MISSISSIPPI.

*To the Committee on Publications.*

GENTLEMEN:—The October number of the *Journal* of your Institute contained an article by Prof. Lewis M. Haupt about "Controlling the Floods of the Mississippi River," which was of special interest to me. But although the premises of the question are exposed in the clearest manner, I regret to

* Mr. Carbutt closed his remarks by exhibiting on the screen a number of slides to further explain the production of monochrome and negatives for three-color process, and expressed his indebtedness for examples of three-color printing, used in the illustration of his remarks, to the Electro-Tint Engraving Company, and the Photo-Chromotype Engraving Company, of Philadelphia.

declare, with all diffidence, that I cannot agree with the author's conclusions, and that I am convinced that if the policy advocated should be followed, the lower Missisippi will be irretrievably lost as a navigable canal and will be converted into a miserable swamp, where numberless anopheles will propagate malaria in the form of yellow fever, cholera asiatica, etc.; where only alligators and snakes can live and no human being can take up his abode without risk of premature death.

The lower Mississippi has much resemblance with the Netherlands as being the Δ of the great river. So the Netherlands are the Δ of three rivers: the Rhine (Ryn), the Meuse (Maas) and the Scheldt (Schelde). In past centuries the fertile banks created by these rivers were converted into pasture lands, by embanking, enclosing them by dykes, extending the enclosed lands by other dykes, and creating the so-called "polders." Sluices let out the superfluous rain water and protected the land against inundation by floods. But in past centuries there was no strong central power and every peasant "impoldered" his land as he liked, without any regard to his neighbor or to the general welfare.

After Charles the Great the feudal system was introduced, and the petty barons, the landed aristocracy, were put under control of the "Graaf" (Count). The landed proprietor who wanted to protect his land by dykes (levees, as the lower Mississippian, after Creole fashion, would say), asked permission and the Graaf granted him a "handfest" (handfast charter). But centralization did not suit the proud barons of these times; many were the intrusions upon the Kaiser's, or his representives', regulations; and if the latter tried to enforce the Kaiser's or his own commands, and perhaps was too attentive to the baron's wife or daughters, the baron made short work with him by slaughtering him on a hunting party (as was the case with Flores V, "der Kerlen Gott," viz., the God of the Carls). Then came the stirring times of the thirty years' war, the struggle for liberty of thought, times of heroic action; but not very apt for peaceful centralization of power. Throughout the whole of the seventeenth century there was a struggle between the central power: the "Algemeene Staten" with the "Provinciale Staten" and the wealthy municipal boards. There was no eminent head of the State. The able "Raadpensionaris," Jan de Witt, had no real power; he derived his power from his commanding spirit and his eminent abilities as a statesman, diplomat, navigator and mathematician. The Princes of Oranje were also recognized more or less as Chiefs, and as long as they shone by their talents at the head of the commonwealth, the petty citizens recognized their power more or less; but beyond diplomatic and military business, their power did not reach very far. And besides, the times were still very unsettled by wars with the British nation under the Stuarts and Cromwell, and against Louis XIV.

The house of Oranje-Nassau died out with William III and its interests were transferred to the Friesian branch, whose ancestor, Willem Lodewyk, was the able coadjutor of the "Vader des Vaderlands," Willem de Zwyger, his brother; but brilliant as were the descendants of the latter, as dull were those of Willem Lodewyk, and the once so brilliant house of Oranje sunk into utter insignificance under William IV and unto worse still under his son, William V, who was ignominiously driven from his seat and the country.

Centralization under these circumstances could not make good progress, at least not from above; but from below there rose a spirit of coöperation, which bore good fruit. The polders who had a common waterway for getting rid of their superfluous water, united themselves into a common "Waterschap," with a board of directors chosen by the "Ingelanden" or petty proprietors; the members of the board were called "heemraden." Smaller concerns were united into greater ones under a board of "Hoogheemraden," chosen by the "Hoofdingelanden;" the later chosen by the "Ingelanden." For the executive there was the "Dykgraaf," which title recalls its mediæval origin from the feudal system The Dykgraaf had his staff of opzichters, fabryks, etc., which we now should call engineers, chief engineers, etc. In this way originated the great Waterschaps or Hoogheemraadschaps of Amstelland, Rynland, Delfland, Schieland, Krimpener-waard, Bommeler-waard, Thielerwaard, etc. (waard-guard, the board to guard the interests of the lands of Krimpen, etc.).

Generally speaking, these boards were admirably organized for guarding the limited interests of their respective Waterschaps, but the country needed a general system of control of the waterways, etc. The consequence was that the rivers above named were badly injured as waterways, as no one took the proper interest in their conservation. The Rhine, the splendid Rhine, smothered near Katwyk in the Downs. Maas and Schelde had an intricate outlet, which was joined by byways from the Rhine. The waterway from Rotterdam, the second port of the country, to sea, became silted up and useless for the India trader. A channel through the Island of Voorne was dug, protected by sluices, and the ships had to pass these sluices and had to be towed from the "Nieuwe Maas" into the "Oude Maas" and to proceed to sea by the "Bokkegatt," but this outlet also became too shallow a waterway. The India trader had to take still another route, the "Brouwerhavensche Gat," by a very dangerous bar, the "Banjaard." This intricate passage from Rotterdam to the sea was even not without its dangers. The Hellegat became silted up and had to be replaced by the "Ventjagersgat." Other difficulties arose from the Δ formation of our great rivers, uncontrolled by man, but aggravated by the uncontrolled action of petty freeholders, of petty towns who wanted their own petty harbors, their own petty waterways, and who sought to improve their own petty interests without regard for the great interests of general public welfare.

After the fall of the Stadhouder system of government, the country came under French influence with its centralizing tendency. In the meanwhile there had risen a remarkable man, Cornelis Rudolphus Theodorus Krayenhof. Bred as a physician, his tastes were for the engineering profession, and in the stirring times of the French revolution he exchanged clyster for compass and took an active part with Marshall Daendels in the defence of Noord-Holland against the invasion of the combined Russians and Englishmen. His part was the regulation of the system of inundations, which proved an impenetrable barrier against the foreign invaders, who were defeated by Daendels at Bergen and Castricum, and had to retire and leave the country. Under King Louis Bonaparte, Krayenhof put Amsterdam in a state of defence and changed it into an impregnable fortress against Napoleon. But Louis, at the last moment, yielded to his brother. Napoleon, who even in his

enemies recognized their merits, was not slow to find them out with Krayenhof, who, under his reign rose to the office of member of the Imperial Committee of Fortifications under the presidency of no less a general than the Emperor himself. After the Emperor's fall, Krayenhof, who had belonged to the anti-Stadhouder's party, although apparently high in honors, was not a favorite at court. William I, a narrow-minded individual, a bad politician, but a good administrator for his own purse, cherished a deep rancor against the old patriot, the "keezendoctor" as he called him; with small intrigues the great man fell as a victim of a miserable cabal, provoked by a sovereign who dared not attack him openly. The old man provoked a legal investigation of his case and was most brilliantly acquitted of every charge which malice had invented, but not long afterwards he died a broken man, burdened by a disgrace from an ignorant, bigot sovereign, the degenerate descendant of one of the most illustrious houses, which traced its descent from Guillaume au Courtnez, one of Charles the Great's paladins.

Krayenhof was a peculiar character; he was a son of his land as well as one of his age. In our country the military man is also more or less a hydrographer or engineer. So, for instance, Krayenhof's great predecessor under William III, the stout baron of Coehoorn, was as eminent an engineer as a tactician and, besides, a technical artillerist. The same may be said of the late F. J. Stieltjes. As a son of his times, Krayenhof started the centralization of the hydrographic condition of his country. A triangulation of the country was executed, and later triangulations with more refined instruments have proved the high degree of accuracy of his work. The reference level of the "Amsterdamsche peil" was spread over the country, and last, not least, Krayenhof projected a general scheme of regulating, or, as it is called in the Netherlands, the normalizing of its river system. The principles of his scheme were the following: each river should have its own well-defined road-bed, undisturbed by the waters of other rivers; Δ formation should be repelled as much as possible.

Meanwhile a new department of public service was created; that of the "Waterstaat," the central controlling body for all matters in relation to the hydrography of the country. This body became celebrated by the dynasties of the Brunings, the Conrads, the Calands. Of these, W. F. Conrad has been before the world's footlights as President of the International Committee of the Suez Canal. A committee of two eminent engineers of the corps of Waterstaat was nominated to consider Krayenhof's plans and propositions, the Messrs. Ferrand and van der Kun, and to project a general plan for the river system. Their report was in favor of Krayenhof's propositions, and in working out his ideas they decided that each river should have a summer-bed, a winter-bed and an inundation or emergency bed; that the river should have a road-bed regularly extending in capacity from its origin to its mouth; the winter-bed should not be interfered with by dykes, zomerkaden (summer-quays or small dykes), etc.; where the bed is too broad it should be regulated by cribs (groynes), and not by dykes (levees); the curves or bends should be as few as possible and with a radius of curvature as great as possible; the mouth should be as broad as possible. These principles were accepted and their execution regularly proceeded with in time. The Rhine was already irretrievably lost; but an artificial mouth was created by a canal with sluices,

cut through the downs, to secure the Watershap of Rynland ready means of discharging its superfluous water into the North Sea. Under Chief-inspector Caland the plans were worked out, and under his guidance the regulation of the Rhine, by giving it an independent outlet through the mouth of the Nieuwe Maas was started, and afterwards the Maas was regulated and got its independent road-bed and mouth through the Oude Maas and Bokkegat. The Rhine now delivers its waters through the Waal and Nieuwe Maas. Its road-bed is systematically regulated short cuts. "Coupures" as those of the Pley were executed to straighten its course; last, but not least, a new mouth was dug at the Hoek van Holland, and the old mouth was dammed up and closed. Long break-waters or jetties constructed of fascines prolonged the new mouth far into the North Sea. The works were crowned with success. Disastrous floods are now a thing of the past. Rotterdam has a splendid waterway into sea, and the inner navigation has not to stop for lack of water in the summer months. Land reclamation goes regularly on without, as in former times, encumbering the river's road-bed.

And when after this long discursion I return to the Mississippi, I remark that Professor Haupt's proposals, at least some of them, are in direct contradiction with the principles which have guided the Waterstaat engineers in the Netherlands and whose works proved so successful. The Professor's proposal of creating "outlets" will prove disastrous and will annihilate the late Captain James B. Eads' great work, undertaken at the risk of his own fortune, and creating upon the same principles which guided our Krayenhof and his followers, and which are still pursued by the Waterstaat, the deep-water canal into sea. Outlets, as proposed, are only palliatives, and, let me add, bad palliatives, which can only afford temporary relief, but if raised to a system will irretrievably spoil one of the finest waterways of the world, which should have its own well-defined summer-, winter- and inundation-bed, unencumbered by levees, dykes, embankments, dams, etc. The Father of the Waters should have a road-bed regularly increasing in capacity from his source to his mouth, with as few curves as possible, and those which cannot be removed should be made as easy as possible. The roadbed should lead directly into sea without sideway-tappings, outlets, etc. It should have sufficient capacity to discharge the waters which the mountains pour into it, in ordinary as well as extraordinary times.

If it were my business I should put the whole basin of the Mississippi under special hydrographic control. The following would be the scheme I should propose.

At the head there should be a chief-inspector, preferably, but not necessarily, an engineer; but an engineer with broad views, not going into details, but one who understands that his embankments, his walls, his canals, are not the ends, but the means to get at the ends; an engineer with a knowledge of practical political economy; with a clear insight in agricultural matters. He should have talent for organizing and executive ability. The choice will be difficult, but is it impossible? No, I believe not. I just mentioned a name, the bearer of which should have been the ideal man in such a place. Eads should have been chief inspector of the great Mississippi. Alas, he is no more! But I have no doubt that there are others who have the needful talents.

The chief inspector should have his staff; besides engineers, it should number within its ranks an agronome, a physician, or let me rather say, a hygienist, a forester and a jurist.

The whole basin should be divided into three great divisions: the mountain, the navigable, and the mouth division, each under a separate inspector, acting under the command of the chief inspector. The second and third divisions should, of course, be controlled by one of the engineering profession, but the first, the mountain division, should be controlled by a forester, assisted by a staff in which the engineering profession, of course, should not be absent.

The divisions should be cut into sections and under-sections, each with its respective chief.

The chief inspector, acting directly under the Government, should be given ample power.

His duty should be, in the first place, to chart the whole basin from a hydraulic point of view; to establish the great river and each of his confluents' summer and winter régime.

This should be the base of his proposal for controlling the river; perhaps in this part of his business he might take some lessons from the work of the Krayenhofs, the Calands, etc., but also from the commissioners of the Clyde, Tyne and other British rivers, from the Donau Committee, etc.

The proposal should include the engineering, administrative and legislative measures for controlling the river.

He should afterwards have to make a working plan with budget, say for the next ten years, with a program for the next; and, lastly, he should have the control of the works in execution.

In this way there would be unity of aim, unity of action. Private interests will be regarded, but become subordinate to public welfare.

From other sources than the *Journal* I know that especially the Lower Mississippi suffers from individual arbitrariness and absence of centralization, but Professor Haupt's article has confirmed me in my supposition. The river needs a central administration. It suffers from the same causes as the Netherlands' river system. It requires the same administrative and technical remedies.

But although as badly spoiled as the Rhine, Meuse and Scheldt in former centuries, perhaps still worse, the task of improving its conditions, although a difficult one, has fewer difficulties to contend with than the Netherlandish engineers, when controlling the above-named rivers. They had to contend with factors which, at least in the Mississippi's lower reaches, do not exist: with ice and its disastrous effects. Besides neither of these rivers has its course wholly within the bounds of the realm, as is the case with the Mississippi. The Netherlands had no control over the forests at the origin; every one who has lived in a mountainous country is aware of the beneficial influence of forests upon a river's régime.

In the above I have briefly sketched my opinions about the manner of controlling the Mississippi, its floods, its mouth, its navigable canal and its banks, and hope I may accomplish some good. Perhaps you will ask what has induced me to publish my views in a matter with which I have nothing to do, what has induced me to meddle with other people's business? Well, gentle-

men, I should answer: it is a technical question, and this is always one interesting me. Besides that, I have always felt a great sympathy for your great commonwealth, and as the Mississippi basin is the greatest in your republic, and millions depend upon its good condition, I could not refrain from giving my views, when I saw that your engineers are on the wrong trail, and to show you what, in my view, is the right one.

Respectfully yours,

H. VAN MEERTEN.

BUITENZORG, JAVA, December 19, 1903.

P. S.—I beg to add to the above, that the monthly illustrated paper *Eigen Haard* (Own Hearth), edited at Amsterdam, contains many well written articles in popular style about Krayenhof, Caland, the Conrads and their works; but for real technical information one should consult the great works about "Waterbouwkunde" and the proceedings of the "Koninklyk Instituut van Ingenieurs."

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*To the Committee on Publication.*

GENTLEMEN:—The paper submitted by the distinguished Dutch engineer, printed herewith, is of great interest for its valuable digest of the evolution of the great works of drainage, reclamation and navigation at the mouths of the Rhine, the Meuse and the Scheldt, which so united their waters as to form a labyrinth of islands and channels which were submerged at high waters and rendered navigation very difficult.

In the comments made on the methods proposed for the regulation of the floods of the Mississippi, he attempts to apply the methods in vogue in Holland for *reclamation* to those proposed in the United States for *navigation*, and suggests that if the excess of flood waters is permitted to escape, the country will become a place for the abode of reptiles and the generation of deadly fevers.

It may seem proper, therefore, to call attention to the fact that in the improvement of rivers, the plans must be governed by the characteristics and conditions which prevail at the locality. It does not meet the case to cite precedents which are so wholly dissimilar as the Rhine and the Delta of the Mississippi. The former lies in 52 north latitude, where ice plays an important part in the obstruction of the mouths, whereas the passes of the Mississippi are near the Tropics and, therefore, exempt from ice. Moreover, the tides, an important factor in the creation of a navigable channel, vary from 5 to 12 feet at the North Sea outlets, while on the Gulf of Mexico they seldom reach 2 feet.

The discharge of the fresh-water floods of the Mississippi through the main outlet, passing New Orleans, may exceed 1,000,000 cubic feet per second, while that on the Holland rivers is very small, and the tides are depended upon to maintain the depths. Neither is there any comparison as to the relative amount of the sediment carried to sea by these two streams, a factor of the greatest importance. The lessons of the works and experiences in Holland would, therefore, not seem to be particularly applicable to the problem of protecting the Mississippi or of improving its navigation, excepting as to the durability and form of the dikes and the character of their materials, all of which have been of great service to mankind.

But while objecting to the relief of the Mississippi by means of outlets, the distinguished writer states that it was found necessary at the mouth of the Rhine, to construct sluices and an artificial canal to "discharge its superfluous water into the North Sea," and thus the Rhine was regulated "by giving it an independent outlet through the mouth of the Nieuwe Maas, and afterwards the Maas was regulated and got its independent roadbed and mouth through the Oude Maas and Bokkegat . . . last, not least, a new mouth was dug at the Hoek van Holland, and the old mouth was dammed up and closed. Disastrous floods are now a thing of the past."

In other words, it is evident that as the floods of Holland are derived mainly from the sea, the remedy most effective there was to dam them out and create artificial channels to provide for navigation through them, but it will be seen that this plan of improvement would be wholly inadequate and ruinous when the flood comes from the interior, so that to place obstacles to its rapid voidance at the natural mouths of the river would be fatal, not only to the navigation, but to the entire country.* As an illustration, the writer refers to the relief afforded by the admirable works constructed by the late Capt. Jas. B. Eads, at the South Pass, between 1874 and 1879, which resulted in opening that pass, but it should also be a matter of record that to secure the depths required under his contract the original jetties were contracted by spurs, and finally by a second set of lateral dikes until the channel was reduced to about 600 feet in width, and that this over-contraction, acting as a partial dam, is causing the entire pass to foul, so that the bed is rising at the rate of nearly 5 inches per annum, and a contract has been let for the opening of the Southwest Pass by two jetties, which vary in width from 3,500 feet at the outer end to about 6,000 feet at the shore, while the pass itself is but about 1,300 feet wide.

This outlet discharges 41 per cent. of the water which reaches the head of the passes, and yet previous Boards have found that in the main reach of the river above its junction with the Red, the normal width to secure a limited depth for low-water navigation should not exceed 3,000 feet. But there is not space to discuss this important question in detail, suffice it to refer to the Report of the Mississippi River Commission for 1903, as to the results secured since its creation in 1879, wherein it states:

"Systematic work, which has for its object to permanently locate and deepen the channel, has not been practicable under existing conditions. In the limited extension and repair of blank protection and contraction work the Commission has, however, kept in mind that the permanent improvement of the river is contemplated by the organic act, and experiments are continually being made looking to the best use of available material and the development of appliances and methods which may be economically and effectively employed when Congress shall provide for such a systematic improvement."

In a river carrying the enormous quantities of sediment which encumber the Mississippi, the problem is largely one of eliminating the solid material and depositing it beyond the channel. This cannot be done by confining it to

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*Let the waters of a river overflow, and it will bring life to meadows and pastures; but if you dam it back it will eventually burst through its banks, a destructive torrent of mire. —*Count Leo Tolstoy.*

the bed and requiring the water to transport it to the mouth, where it must be ejected in front of the stream, thus rapidly extending it gulfward and reducing the slope. It is found that at the two lateral outlets known as Cubitt's Gap and the Jump the river has deposited about 150 square miles of sediment in thirty years, reclaimed that much land and the navigable channels have not been impaired. To have accomplished this by dredging would have cost about $1,500 per acre. By this process of hydraulic grading it cost nothing.

But recurring to the experience of the Dutch engineers, in the effort made to regulate the floods by dikes, the record states: "That the rivers cannot at all times, any more than the sea, be kept under control by the dykes, is shown by the floods of 1775, 1776, 1784, 1799, 1809, 1820, 1861, etc." (*Enc. Brit.*, Holland, p. 65.)

That the creation of a free discharge near the mouth to void the floods rapidly would not injure the works of Captain Eads, as alleged, is demonstrated not only by the large crevasses which existed when his jetties were constructed, but by the Pass a Loutre crevasse, which has been in existence since 1891. Moreover, streams do not deposit on a falling stage so readily as during a rising one, resulting from the reduction of velocity by obstacles placed in their paths.

The author of the paper fears, therefore, that his methods have not been thoroughly understood by his friend in far-off Java, or probably that the latter has not given due weight to the sediment problem and the need of separating it from the water of the stream wherever it may be possible by permitting the natural hydraulic motor to eject it beyond its navigable channel, instead of depositing it in its bed to obstruct both the discharge of its waters and the passage of its commerce.

For a more elaborate discussion reference is made to a paper read at the annual convention of the American Association for the Advancement of Science, at St. Louis, December 28, 1903, and published in the *Proceedings* of the American Philosophical Society of Philadelphia, 1904.

LEWIS M. HAUPT.

PHILADELPHIA, March 2, 1904.

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## Annual Reports of the Schools of Drawing, Machine Design and Naval Architecture for the Sessions of 1903-1904.

THE DRAWING SCHOOL.—This school is an excellent indication of the condition of the engineering industries, and shows the ups and downs of the demand and supply of draughtsmen and technical workers to a remarkable extent. The last few terms have been the crest of the wave, and this spring term has shown the receding tide. Although the falling off has been slight, the indication is there, nevertheless.

But there is a compensation for this in that the best students utilize the dull times to increase their knowledge and to prepare themselves for the increased demand which is sure soon to return. Consequently, in dull times

the school is full of serious workers, bent upon making the most of their spare time, when they can combine work at school with work at home, and thus get the very most from the opportunities offered.

WM. H. THORNE,
*Director.*

THE FOLLOWING STUDENTS HAVE DESERVED HONORABLE MENTION:

*In the Senior Mechanical Class.*

Ross Rodgers,
Walter Baylie,
J. Monroe Bowen,
Walter D. Williams,
William Derr,
George Moxley,
Herman Fink,
Chester D. Thorpe,
William A. Janton,
Clarence N. Haven,
James L. Scanlin,
Albert F. Heeley,
James P. Conway,
Philip Hochman.

*In the Intermediate Mechanical Class.*

Walter T. McGrath,
E. Carman Gardiner,
James McCairns,
Charles Harrison,
Thomas F. Kelley,
Herman Sangtinetti,
Arthur Sherbourne,
H. Nelson Poole,
John Reilly,
Irenée P. Pedrick,
Charles W. Pfeiffer.

*In the Junior Mechanical Class.*

John G. Collins,
Merwyn McKnight,
H. L. Schwenk,
G. Hollinger,
P. Saltzmann,
David B. Robinson,
Frank H. Shepherdson,
Frederick Graff Groves.

*In the Architectural Class.*

William N. McCully,
Horace Tomlinson,
Harry Stull,
Charles Wilson.

*In the Free Hand Class.*

David Bowers,
Gustav D. Lemmerman.

THE FOLLOWING STUDENTS ARE AWARDED SCHOLARSHIPS FROM THE B. H. BARTOL FUND, ENTITLING THEM TO TICKETS FOR THE NEXT TERM:

Arthur J. Beuter,
Charles W. Leeds, Jr.,
J. Crankshaw,
Joseph Hadik,
Charles Huegle,
Valentine Huegle.

THE FOLLOWING STUDENTS, HAVING ATTENDED A FULL COURSE OF FOUR TERMS, WITH SATISFACTORY RESULTS, ARE AWARDED CERTIFICATES:

Ross Rodgers,
J. Monroe Bowen,
Walter D. Williams,
William Derr,
George Moxley,
Herman Fink,
Albert F. Heeley,
James Taylor,
Harry Groben,
George Muth,
John H. Wackenhut,
E. N. Hannum,
Robert H. Pickering,
John P. Knapp,

Chester D. Thorpe,
William A. Janton,
James P. Conway,
James L. Scanlin,
Gomer W. Hagstrom,
Norton Fleu,
J. Alten Whitecar,
Fred. Randle,
Mark F. Ruhe,
Clarence Brown,
Edward A. Collins,
John Ridgway,
Charles Ludwig,
Philip Hochman,
Horace Tomlinson,
Daniel R. Finkbiner,
Arthur Friant,
William N. McCully,
H. Nelson Poole.

THE TIOGA BRANCH DRAWING-SCHOOL.—We have had a considerable increase in the number of students during the past year, and for this reason have been compelled to seek new quarters, located at Kenderton Hall, Seventeenth and Venango Streets, Tioga. This place has double the capacity of our former school, but we find that our space is already getting crowded and our present trouble is to obtain a suitable building large enough to accommodate all applicants, and at a rental within the means of the school.

We are pleased to say that this year has been the most successful in regular attendance, neatness and accuracy of work. The increased interest shown by the manufacturing concerns in this locality in recommending their young men to attend drawing-school has also been very gratifying. We also beg to offer our thanks to the George V. Cresson Company and Midvale Steel Company for the financial support extended by them, without which we would not have been able to carry on this work.

H. E. NORBOM,
*Director.*

NAMES OF GRADUATES, FRANKLIN INSTITUTE BRANCH SCHOOL, SPRING TERM, 1904:

Walter Andrew,
Harry L. Harley,
Charles W. Ritzer,
Thomas K. Berry,
Thomas V. Burke,
John W. Duval,
Anders F. Forsstrand,
Thomas C. Haskins,
George W. Nise,
William Gregson,
Robert A. Hemphill,
Samuel Mason,
Alfred W. Hendershot,
Harry V. Tarbuck,
James B. Riley,
J. Aloysius Thompson,
John J. Melloy.

THE SCHOOL OF MACHINE DESIGN has just completed a successful year. Though the attendance has not been quite up to that of last year, those who did attend did so regularly, and gave evidence of being deeply interested in the work. Owing to the limited number of applicants for the courses in "Kinematics of Machinery and Machine Design," these were omitted last year, but we have good prospects of having a class in these subjects next year, and they will be taught as heretofore.

Two scholarships were awarded in the algebra class. The first, which entitles the holder to one year's tuition at the Institute, was given to the student obtaining the highest average in the examinations for the winter and spring terms. The second, which entitles the holder to one term's tuition, was given to the student having the second highest average.

We believe, from the experience of the closing season, that these rewards have a stimulating effect upon the students, and that it would prove of great benefit to the School of Machine Design if we had a fund such as that endowed by the late B. H. Bartol for the benefit of the Drawing School.

The classes in geometry and trigonometry have been under the direction of Mr. Clayton Worrall, and have been well prepared for the more advanced work next year. Mr. Yeats, a man of wide experience as a teacher, has ably assisted with the algebra.

The classes in Theoretical Mechanics and Strength of Materials have been well attended, and the students have now a good working knowledge of the design of beams, columns, shafts to withstand torsion, etc. In addition to this they have taken up the fundamental principles of graphical statics, and have drawn the stress diagrams for a number of roof trusses.

The following students have passed the examinations, their names, reading accross columns, being arranged in order of merit.

L. M. ARKLEY, *Director.*

*Mechanics.*

| | |
|---|---|
| F. E. Fisher, | M. O. Stilson, |
| F. B. Wetherill, | E. Schmeltzer, |
| C. Fithian, | Thos. Jones, |
| Geo. Keefe, | J. C. Warren. |

*Strength of Materials.*

| | |
|---|---|
| M. O. Stilson, | C. Fithian, |
| Thos. Jones, | J. C. Warren, |
| E. Schmeltzer, | F. B. Wetherill, |
| Geo. Keefe, | F. E. Fisher. |

*Geometry.*

| | |
|---|---|
| Fred. Ruch, | Wm. Fulmor, |
| *A. Cramp, | *E. Kirchuebel, |
| *L. W. Krout. | |

*Trigonometry.*

| | |
|---|---|
| Fred. Ruch, | Wm. Fulmor, |
| E. Kirchuebel, | A. Cramp, |
| L. W. Krout. | |

*Algebra.*

| | |
|---|---|
| D. Brierley, | Wm. McGonigle, |
| W. Magann, | F. S. Hodge, |
| C. Bockius, | J. Long, |
| S. Dougherty, | J. A. McLean, |
| R. Morrison, | A. Armitage, |
| A. Forstrand, | E. Stranahan. |

D. Brierley is awarded the first scholarship; Wm. McGonigle the second.

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*Those marked with the asterisk obtained the same number of marks.

SCHOOL OF NAVAL ARCHITECTURE.—I have the honor to report that the School of Naval Architecture has met with decrease in its enrollment from last year, owing to the local depression in shipbuilding, but the average attendance of the senior division students during the winter term was 98·6 per cent., and for the spring term 98 per cent., the majority of this division making the full attendance; that of the junior division was 90 per cent. for the winter term and 80·6 per cent. for the spring term. Eight of the senior division have attended the full term of two years and, having passed the examinations, will be graduated.

The senior class in Practical Naval Architecture has studied the various details in construction of the different classes of vessels, making sketches and calculations for the same. In Theoretical Naval Architecture they have calculated weights of material, centers of gravity, strength of structure of the hull under varied conditions, trim, stability, etc. Their home work has shown wonderful energy, considering that the drawings, etc., are made without the usual adjuncts of a drawing office. In fact, this class has exhibited more than ordinary intelligence and its members are above the average, being neat and painstaking.

The junior students have progressed rapidly in both theoretical and practical naval architecture, and have also shown marked zeal in their work in class and at home. Numerous drawings beyond the average in neatness and accuracy have been made from blue-prints lent for that purpose.

ALEX. J. MACLEAN, *Director.*

*Philadelphia, April 22, 1904.*

THE FOLLOWING STUDENTS ARE AWARDED CERTIFICATES:

Charles C. Brush,
Henry A. Burkholder,
Robert Deichmann,
Theodore H. Gloeckner,
Fred. C. Griggs,
Luther W. Krout,
James C. Vanderslice,
Reginald H. Waters.

THE FOLLOWING STUDENTS ARE ENTITLED TO HONORABLE MENTION, HAVING ATTENDED ALL SESSIONS AND SHOWN GENERAL EFFICIENCY:

J. W. Sutton,
Theo. H. Gloeckner,
J. C. Vanderslice,
L. W. Krout,
A. S. Reed, Jr.,
Jos. McDermott,
Chas. C. Brush,
Chas. McMenamin,
C. M. Andrews,
H. A. Burkholder,
C. D. Wallack,
H. C. White,
R. Waters,
Lionel Levy,
I. Aarum,
Fred. C. Griggs,
Jas. B. Baker, Jr.,
Elmer Hicken.

# Notes and Comments.

## THE LIGHT ALUMINUM ALLOYS.*

By Joseph W. Richards.

Chromium hardens aluminum strongly. The chromium-aluminum alloys have somewhat of the qualities of self-hardening steel, retaining their hardness on heating or after annealing. The use of 2·3 per cent. chromium is recommended; 11 per cent. makes a brittle alloy. Chromium-aluminum alloys are being used commercially. Titanium-aluminum alloys are difficult to make and have practically gone out of use. Alloys of aluminum and manganese, up to 5 per cent. manganese, are hard and rigid. When used with copper and nickel manganese makes the hardest light alloy yet produced. The manganese should be employed in the form of a rich aluminum-manganese alloy produced in the electric furnace. The alloys of aluminum and tin are not much used. Tin makes aluminum whiter and more easy to solder. The aluminum-silver alloys are harder, stronger and whiter than pure aluminum, take a higher polish and retain it better than pure aluminum. They are used for making table ware and ornamental articles. The alloys of nickel and aluminum have not yet been found useful. The commercial alloys which go under the name of "nickel-aluminum" are really alloys of aluminum with nickel and copper; when made for rolling, they contain from 2 to 5 per cent. nickel and copper together, the larger proportion being usually copper. The plates of the yacht "Defender" were made of this alloy. The precise effects of tungsten on aluminum have not been satisfactorily determined. An aluminum alloy containing a small amount of tungsten has been used extensively for military equipments. Aluminum alloyed with 2 or 3 per cent. of German silver gives a strong, tough metal which is easily made. An aluminum alloy containing 10 per cent. magnesium is being used in Europe. Zinc is the cheapest and one of the most efficient metals with which to improve the mechanical qualities of aluminum. Up to 15 per cent. zinc, these alloys are malleable; in castings as much as 33 per cent. zinc may be used. Casting in chills gives better results than in sand. The zinc-aluminum alloys are made by melting aluminum and adding zinc thereto. The 15 per cent. alloy can be rolled and drawn. The 33 per cent. alloy, sometimes called "Sibley casting alloy," is extremely rigid, but is not so resistant to shock as the alloys containing less zinc.

In the preparation of aluminum alloys the best results are obtained by the use of pure metals, this being especially the case with respect to zinc. In general, the aluminum should first be melted, the other metal being subsequently stirred in. The melting can be performed in an ordinary graphite crucible, but magnesia-lined crucibles are best for this work. In alloying, recovering of charcoal is needed; but simply for melting, no covering is required. It is important that the metal should not be overheated; it is of the greatest importance that it should never be over a cherry-red. A wrought-

* Notes from a paper read before the American Society for Testing Materials, at Delaware Water Gap, July 3, 1903.

iron stirring rod may be used, but a carbon rod with an iron pipe for a handle is better. The alloys should be allowed to cool down before pouring. The use of a flux in melting is not recommended. For general castings, green sand is suitable. Large gates, heavy feeders and numerous air vents are necessary. Slabs and rods for rolling or drawing are cast in chill molds, as the metal is soft, uniform and stronger than if cast in sand, and the surface is smoother. Since the alloys are hardened and stiffened by working, they must be annealed frequently during rolling. Slabs or billets are best broken down by a steel hammer while at temperature of 150° to 250° C.; steel rolls with good surfaces should be used, and the rolls should be at temperature of 150° to 200° C.

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## ASPHALT IN THE INDIAN TERRITORY.

In view of the fact that 7,239 acres of asphalt land in the Indian Territory will be disposed of at public auction in a few months, it may be interesting to many people to know something about these deposits. Over 2,000 acres of these lands are in the Tishomingo quadrangle, which has been surveyed, topographically and geographically, by the United States Geological Survey. Mr. Joseph A. Taff is the author of the geologic folio which was recently published as a result of these surveys. In this he gives a detailed description of the asphaltic deposits of the quadrangle.

Those deposits which are of economic importance are found in the vicinity of Gilsonite, near the northwest corner of the quadrangle. They occur chiefly as impregnations in the sandstones, limestones, conglomerates, and grits of three distinct geologic formations.

*Bituminous sandstone.*—The richer bituminous sandstone contains 7 to 12 per cent. of bitumen, and grades outward into the barren sand in peculiar ways. In some instances the bitumen occurs in layers or streaks parallel with the bedded structure and alternating with the purer and, at present, porous sand. There are at least five acres of economically valuable bituminous sandstone in the vicinity of Gilsonite. Four of these are in the Tishomingo quadrangle and the fifth is just beyond its border, on Rock Creek, 2 miles a little north of west from Gilsonite. In the mine at Gilsonite the impregnations of bitumen have entered some of the associated siliceous and fossiliferous limestone layers. A second area of bituminous sandstone occurs nearly a half mile west of Gilsonite. In the N. W. ¼ of section 22, T. 1 S., R. 3 E. there is a third area of bitumen impregnating the sandstone. Here there are three quarries, known as the Kirby mines. The fourth area of the bituminous sandstone in the quadrangle is in the eastward extension of the same sandstone member as that in which the Kirby mines are located. The two mines located in the bituminous sandstone of this area occur half a mile north of Gilsonite, in the south side and west end of a low ridge capped by a heavy limestone conglomerate. The fifth and least valuable bituminous sandstone deposit known in this vicinity occurs at the base of the high bluff in Rock Creek, near the southwest corner of Section 21. T. 1 S., R. 3 E. Only a small area of the highly bituminous sandstone occurs here.

*Bituminous limestone.*—The better grade of bituminous limestone carries 5 to 6 per cent. of bitumen. It occurs in two areas, one at Gilsonite and the

other 1 mile to the southwest. Two mines have been located upon the bituminous limestone 1 mile southwest of Gilsonite. The larger of these is at the extreme west end of the Viola limestone ridge and the other on the crest, about 600 feet farther east. The bituminous limestones are most advantageously situated for economical mining, being in a bluff 50 feet high, at the terminus of the ridge where the rocks are steeply tilted southward, exposing more than 300 feet of strata. Of the 340 feet of bituminous limestone at this locality, 128 feet in the lower part contain 5 to 6 per cent. of bitumen.

*Bituminous rocks in Carboniferous conglomerate.*—Certain beds about half a mile west of Buckhorn contain the richest bituminous deposits known to occur in this field. The bituminous and associated beds consist of conglomerate, grits, shale and limestone interstratified. The richest bed, which is locally conglomerate at the base and about 10 feet thick, will produce approximately 14 per cent. of bitumen.

This Folio (No. 98) may be obtained for 25 cents from the Director of the United States Geological Survey, Washington, D. C.

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## NEW IRON-NICKEL ALLOYS.

Two of the remarkable alloys discovered by Dr. Guinaume in his study of high nickel and iron compounds are now made on a commercial scale. The first, to which the trade name "Invar" has been given, contains 37 per cent. of nickel, and after special heat treatment is practically unalterable in length between the ordinary ranges of atmosphere temperature, the dilation per degree Fahrenheit being only 1-36 inch per mile. This is coming into use for standard bars, wires for base line measurements, and other geodetic purposes, as well as for the pendulum rods of astronomical clocks and the compensation balances of chronometers. The alloy containing 46 per cent. of nickel, known as "Platinite," has the same coefficient of expansion as glass, and may, therefore, be substituted for platinum in the manufacture of incandescent electric lamps. It has also been used in Appert's armored glass, in which a wire network is inclosed between two plates of glass.—*Iron Age.*

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## TIN IN ALASKA.

The outlook for tin mining in Alaska is improving. Lode tin has been found in the Lost River district, about 30 miles east of Cape Prince of Wales. The tin occurs in a dike of granite traversing limestone. Prospecting is now going on at this locality and the outlook appears to be good. The reconnaissance work of the United States Geological Survey indicates that the distribution of tin in the Seward Peninsula is wider than supposed, although the occurrence of placer tin has only been proved in the creeks at York, and in the valley of the Snake River, 100 miles east of York and about 20 miles inland from Nome. The cassiterite is grayish brown to black, and is more often confused with magnetite than with garnet. Even tourmaline has been mistaken for tinstone by prospectors unfamiliar with the mineral. With better knowledge and more extended search, it is likely that the United States may again include tin among its important metallic products.—*Engineering and Mining Journal.*

# Book Notices.

*Present College Questions:* Six papers read before the National Educational Association, at the sessions held in Boston, July 6 and 7, 1903. By Charles W. Eliot, President of Harvard University; Andrew F. West, Dean of the Graduate School, Princeton University; William R. Harper, President of Chicago University; Nicholas Murray Butler, President of Columbia University. 8vo, pp. viii + 105. New York: D. Appleton & Co. 1903. (Price, $1.00.)

This collection of six addresses presents the views of representative men prominently identified with higher education in America, on a number of debatable questions affecting the future of the American college.

The following subjects are discussed: A New Definition of the Cultivated Man (Eliot); the Present Peril to Liberal Education (West); the Length of the College Course (Eliot, West, Harper, Butler). W.

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*Die Herstellung der Akkumulatoren.* Ein Leitfaden. Von F. Grünwald, Ingenieur. Mit 91 in den Text gedruckten Abbildungen. (3te Auflage.) 12mo, pp., viii + 158. Halle a. S.: Druck u. Verlag von Wilhelm Knapp. 1903. (Price, 3 marks.)

The work above named treats concisely of the following subjects: The generation and action of the voltaic current; the development of the lead accumulator and the conditions governing its construction; the materials of the lead accumulator and their treatment; the behavior and handling of accumulators; application, shunting and operation of accumulators; official regulations and data. The illustrations are numerous. To those familiar with the German, the work should prove a useful reference book. W.

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*The Mechanical Engineer's Pocket-Book* of tables, formulas, rules and data. A handy book of reference for daily use in engineering practice. By the late D. Kinnear Clark, M. Inst. C.E., etc. (5th edition, revised throughout and enlarged.) By H. H. P. Powles, M.I.M.E., A. M. Inst. C.E. 12mo, pp. xxxii + 602. New York: D. Van Nostrand Co. 1903. (Price, $3.00.)

The various reference books edited by the late Mr. Clark have for years enjoyed a standing among the engineering fraternity second to none in the English language, being equally well known and esteemed on both sides of the Atlantic.

The work above named is issued in handy pocket-book form, and contains formulas, rules and data covering every topic of importance that will be likely to engage the attention of the mechanical engineer. The circumstance that much of the work is founded on English practice, so far from detracting from its utility to American engineers, will in many cases make it of special value to them, as it will usefully supplement the many American pocket-books.

The present fifth edition of the book has been carefully revised by the editor and brought up to date. This is especially true of the section relating to Electrical Engineering. W.

*The American Steel Worker.* A twenty-five years' experience in the selection, annealing, working, hardening and tempering of various kinds and grades of steel. By E. R. Markham. First edition. 8vo, pp. 343. New York: The Deery-Collard Company. 1903. (Price, $2.50.)

Except Byrne's universally-known "Metal Worker," the reviewer can call to mind no practical guide book that can compare, favorably, with Mr. Markham's book as a practical guide and instructor for the artisan.

The author takes up successively the various manipulations of forging, hardening, tempering, welding, etc., with which the skilled steel worker must be familiar, and describes in the most minutely detailed manner every step of these processes. Not only this, but what perhaps is of equal value, he culls from the store of his great experience the numerous difficulties that beset the inexperienced hand, and illustrates, by precept and example, the numerous errors that must be avoided to achieve success.

The conversational style adopted by the author is admirably adapted for his purpose of imparting advice and instruction to practical men. The publishers, also, have done their part of the work well, the printing and illustrations being unusually good. W.

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*Traité Theoretique et Pratique des Moteurs à Gaz et à Pêtrole.* Par Aimé Witz, Ingénieur des Arts et Manufactures, Docteur ès Sciences, Professeur à la Faculté Libre des Sciences de Lille, etc, etc.; 4ᵉ édition, refondue et entièrement remaniée. Tome ii (4to, pp. 505–1135). Paris: E. Bernard, Imprimeur-Editeur. 1904.

The present volume constitutes the second part of the exhaustive treatise of M. Witz, the first portion of which was noticed in the *Journal* about a year ago. This volume is devoted specially to a detailed description of the construction and operation of the principal exemplars of the several types of gas and petroleum engines. The engineer who is seeking information on this subject will find in this work, in which the text is admirably supplemented by engravings of every needful detail of construction, a mine of useful information.

The two volumes of the work make perhaps the most complete monograph on oil and gas engines that has thus far appeared. W.

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*Photographic Lenses.* A simple treatise. By Conrad Beck and Herbert Andrews. Second edition. (16mo, pp. 320.) London: R. & J. Beck, Ltd., and Percy Lund, Humphries & Co., Ltd. New York: Tennant & Wood. 1903. (Price, cloth, 75 cents; de luxe, $1.00.)

The character and scope of this booklet are accurately described by the title. It is the work of two practical lens-makers, and is intended to serve as a practical guide for the use of the practical photographer, who, without the opportunity or desire to master the subject of photographic optics, wishes to be able intelligently to choose the lenses best adapted for his requirements, and to use them to the best advantage. This is the kind of information which the book covers, and presents in readily comprehensible language.

The book is profusely illustrated with diagrams and with half-tones, showing by comparison the results obtained by the use of different lenses. A convenient feature is a marginal index of topics. W.

*Thonindustrie Kalender*, 1904. 12mo, pp. 762. (II Theil.) Verlag der Thonindustrie Zeitung. Berlin, 1904.

This useful handbook is designed primarily as a general reference book for the use of German industrials engaged in the affiliated clay industries—the producers of raw materials, manufacturers of cement, bricks, tiles of every description, refractory materials, drain pipes, pottery, etc., etc.

It covers also the construction and operation of kilns and furnaces, the special machinery employed in the art, steam machinery and appliances, and, in brief, every topic that might be supposed to interest the clay worker.

W.

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*Die Elektrometallurgie der Alkalimetalle.* Von H. Becker. Herausgegeben von "L'Industrie Electrochimique." (Mit 83 Figuren und 3 Tabellen im Text. 8vo, pp. viii + 135. Halle a. S.: Verlag von Wilhelm Knapp. 1903. (Price, 6 marks.)

This timely publication constitutes Volume IX of the series of "Monographs on Applied Electrochemistry" now appearing from the press of the above named publisher. The author first treats of the chemical methods of producing the alkali metals; then takes up the modern electrochemical methods, treating these under two divisions—Electrolytic and Electrothermic.

It should prove a useful reference work to all who are interested in the subject.

W.

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# Franklin Institute.

[*Proceedings of the stated meeting held Wednesday, April 20, 1904.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, April 20, 1904.

MR. H. R. HEYL in the chair.

Present, 138 members and visitors.

Additions to membership since last report, 13.

Mr. Herbert L. Heyl was unanimously elected as Trustee of the Elliott Cresson Fund, in place of Mr. S. Loyd Wiegand, deceased.

Mr. M. R. Hutchinson, of New York, gave a description of the Hutchinson System and Apparatus for the Alleviation of Deafness, and the Instruction of the Deaf-Mute.

The speaker illustrated his remarks with the aid of numerous lantern photographs, and gave a most interesting demonstration of the application of several forms of his apparatus, using as subjects several of the children—pupils of the Philadelphia Institution for the Deaf and Dumb. The subject called forth considerable discussion, participated in, chiefly, by Principal Crouter and several of the instructors of the Institution named above, and the speaker.

The subject of Mr. Hutchinson's inventions was referred to the Committee on Science and the Arts. After a vote of thanks to the speaker the meeting was adjourned.

WM. H. WAHL,
*Secretary.*

# Sections.

[*Abstracts of stated meetings.*]

ELECTRICAL SECTION.—*Stated meeting*, held Thursday, March 31, 8 P.M. Mr. Thomas Spencer in the chair. Present, 122 members and visitors.

Dr. Lee de Forest, of New York, representing the De Forest Wireless Telegraph Company, read a paper on "Wireless Telegraphy." The speaker gave a brief sketch of the various systems that have been suggested and (in some cases) put in actual service, and devoted the remainder of his remarks to a description of the system which bears his name and which is at present in successful operation.

The paper was discussed by Messrs. E. A. Scott, Carl Hering, Dr. E. Goldsmith, Prof. G. A. Hoadley, the Chairman and the author. (The paper, with discussion thereon, will be printed in the *Journal*.)

The thanks of the meeting were voted to Dr. De Forest.

RICHARD L. BINDER,
*Secretary*.

SECTION OF PHOTOGRAPHY AND MICROSCOPY.—*Stated meeting*, held Thursday, April 7, 8 P.M. Dr. Henry Leffmann in the chair. Present, 98 members and visitors.

Prior to announcing the communications of the evening the chairman called attention to several exhibits which were of more than usual interest.

The first of these consisted of several specimens of the "Parallax Stereograms" of Mr. Fred. E. Ives. This optical device was originally exhibited several years ago at one of this Section's meetings, but has since been improved, and is now being commercially exploited.

The second exhibit consisted of specimens of photographs in natural colors of natural objects and of paintings made by a photographic process devised by Messrs. M. Miley & Sons, of Lexington, Va.

The resulting photographic prints exhibited surprisingly close approximations to the coloring of the originals and were much admired.

The regular communication of the evening, "Microscopic Studies with the Moving-Picture Camera," was a highly interesting demonstration, showing many minute living organisms, etc., that had been magnified many times by the microscope and then photographed by the method used in making moving pictures. Among a number of subjects thus exhibited, the circulation of blood in the web of the frog's foot, and the circulation of cell fluid in living waterweed, are specially worthy of notice.

The exhibits were explained and commented on by the chairman, and, at the close of the meeting, the thanks of the meeting were tendered to Mr. S. Lubin, of Philadelphia, who supplied the material and moving-picture camera for making the demonstration.

M. I. WILBERT,
*Secretary*.